JUNE 1957

Power Engineering

SPECIAL REPORT on HEAT EXCHANGERS

Repair and Retubing of Tubular Heat Exchangers 67
How To Remove and Replace Tubes 69
How To Roll Tubes Correctly 70
Important Points in Repair Practice 72
Is It Right To Burn Coal? 74
What Should You Do About Spare B-F Pumps? 76
APPR Begins Operation at Fort Belvoir 78
How You Can Use Exhaust Heat From a Gas Turbine 84
Why and How EBWR Steam Is Different 86
Purge Your Steam Turbines When Starting Up 89
China Develops Big Hydro Systems 91
What It Costs To Modernize Small Industrial Power Plants 92
Germanium Rectifiers Hit the Big-Time 96
Here's How To Cut Fuel Costs With an O_2 Analyzer 98
Latest Tips on How To Inspect Power Transformers 110

REGULAR DEPARTMENTS

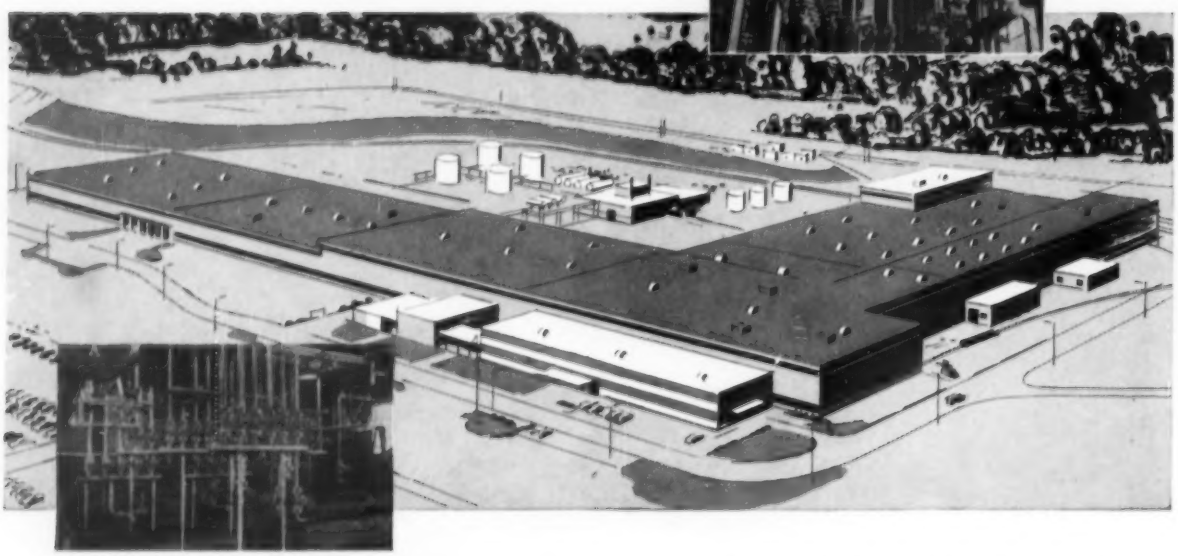
Engineers' Preview 3
What They Tell Us 6
Helpful Bulletins 25
Construction News 46
Equipment News 48
Power Engineering Handbook 104
Catalog Library 127
Reader Service Post Cards 127
Advertisers' Index 142
Circulation of This Issue 41,210

You see OIC Valves everywhere

at the new General Electric Distribution Transformer Plant, Hickory, North Carolina.

STEAM

OIL PROCESSING



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The name *General Electric* is a promise of quality to users of complex electrical equipment. To help make good that promise, GE insists on this same high quality from its own suppliers. That's why you see OIC Valves of many types in nearly all valve installations in this new General Electric plant.

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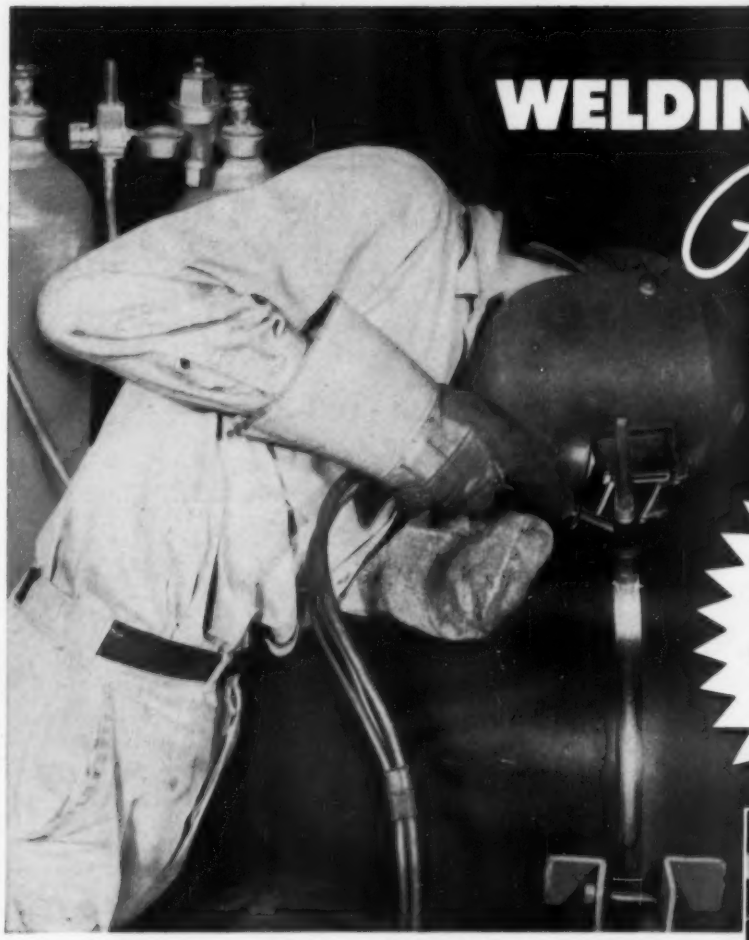
OIC VALVES

FORGED & CAST STEEL, BRONZE & IRON, LUBRICATED PLUG VALVES

For more data circle 501 on Post Card

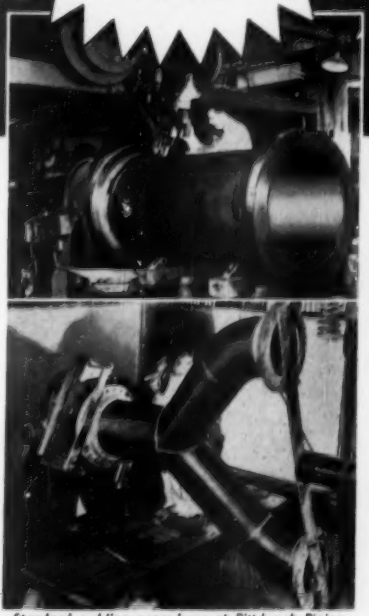
WELDING at Pittsburgh Piping



another P. P. & E. service which contributes to *Improved* HIGH-TEMPERATURE HIGH-PRESSURE PIPING

Modern power and process piping fabrication requires the highest degree of welding skill, as well as technical supervision which provides complete control of welding procedures. All Pittsburgh Piping welders and welding operators are performance qualified in accordance with Standard A.S.M.E. Welders' Qualification Test. They are specially trained in the exacting requirements of fabricating piping and related equipment for high-temperature, high-pressure central station service, corrosion-resistant applications, and nuclear power installations.

Fabricated high pressure boiler feed piping shop fabricated at Pittsburgh Piping. Comprises bends and forged laterals.



Standard welding procedures at Pittsburgh Piping are: inert gas tungsten arc (above); automatic submerged arc (center); and manual metallic arc (bottom).

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PP-20

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NBP BPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

ENGINEERS who have to use conversion factors frequently in their work will find about 400 of these factors — both the commonly-used ones and many unusual ones — tabulated on an 8½ by 11-in. chart recently published by Precision Equipment Co, 3716 N Milwaukee Ave, Chicago 41, Ill. This gives multipliers for converting from one system of units to another.

For example, if you have inches of water, you multiply it by 0.07355 to obtain inches of mercury. If you have gallons, you multiply by 0.1337 to obtain cubic feet; and so on. To get 400 items on a chart that size means pretty small type, and you might want to have the chart enlarged if you need to use it frequently. But if you want a copy of it, write Precision Equipment Co at the above address.

CONCERNED that the great demand for engineering graduates will lead to excesses in college recruiting, the American Society for Engineering Education and the Midwest College Placement Association have joined to prepare a new *code of ethics* on Recruiting Practices and Procedures.

The code says — in effect — that industry, colleges, and students must especially seek to be prompt, businesslike, and honest in their placement activities because of the temptations of today's keen demands for graduates.

Copies of the new *code of ethics*, Recruiting Policies and Procedures, are available from the Secretary of the American Society for Engineering Education, University of Illinois, Urbana. Single copies are priced at 25 cents each; but substantial discounts are given for quantity purchases.

WHAT WON'T they think of next! Patents have been issued, according to an announcement by the American Viscose Corp, for power-driven shuttle mechanisms for looms. According to one of the patents, the shuttle of the loom is driven by a fluid propellant such as liquid or gas. At each side of the loom is located a small gasoline cylinder, and the shuttle furnishes the compression cycle and actuates the spark for exploding the gas.

In an earlier patent, the shuttle is driven by solid explosive charges fed to the shuttle propulsion unit by a paper tape. A third invention now pending relates to time-delay mechanisms for power-driven shuttles.

Use of such power driven shuttles, it is stated, may eliminate about 35 moving parts on present looms, reduce vibration, increase loom speed, and make it possible to weave fabrics wider than those possible with conventional present day looms. It is also claimed that the new shuttle can be incorporated in new looms or in existing looms.

Another Associate Editor Wanted for POWER ENGINEERING

AS A RESULT of our recent advertisement, we have added one well-qualified electrical engineer associate editor to the POWER ENGINEERING staff. We have another opening for a mechanical engineering graduate, between 30 and 45, with broad steam-electric plant operating experience in utilities and/or industry. Holding of PE license would be an advantage, as would some knowledge of diesel, hydro, refrigeration and compressed air.

The man we want must have a good personality, like to travel some, and investigate new developments over the country. Previous editorial experience is not required.

If you are interested and meet these specifications, send a photograph and resumé of your experience to the Editor, POWER ENGINEERING, 110 S Dearborn St, Chicago, Ill.

First three graduates of the only engineering secretarial course in the country

PURDUE UNIVERSITY has announced the establishment of a Thermophysical Properties Research Center with two long-range objectives: *(1)* To serve as a world center for research and for the collection, analysis, correlation and dissemination of data on thermophysical properties; *(2)* To provide unique facilities and opportunities for graduate study and research on thermophysical properties.

Full information about the subjects studied by this center, its plans for the future, and what it can mean in your work, may be obtained by writing to W. S. Touloukian, Associate Professor of Mechanical Engineering and Director, Thermophysical Properties Research Center, Purdue University, Lafayette, Ind.

FIRST engineering secretarial students in the nation were graduated this month from the Business Training College in Pittsburgh. Reading left to right are graduates Patricia Shafley, James W. Sneddon and Kay Jack, shown with Dr. Dorothy C. Finkelhor, founder of the college. We described this course in *Engineers' Preview*, December 1956 issue.

These are the first three students to complete the two-year engineering secretarial course established in 1955. It is the only such course in the country. From it, 22 juniors will be graduated in 1958. This engineering secretarial course was patterned after the successful Medical Secretarial Course which has been given at the college for more than 13 years.

The Engineering Secretarial Course features extensive training in engineering terminology, complete mastery of the secretarial skills, instruction in physical sciences, chemical experiments, slide rule, drafting, blue print reading and visual aids. Guest lecturers address the students on engineering subjects during the entire two-year program and field trips are arranged. This training enables graduates to serve as administrative assistants and aides to busy engineers.

During the summer, between the junior and senior years, students are placed in engineering and professional positions, full or part time, thereby enabling them to gain additional terminology. At the same time they learn more of the administrative and business office techniques of the profession. A lifetime free placement service keeps the students and graduates fully informed of positions and opportunities available in the United States and abroad.

WALKER LEE CISLER, president and chairman of the board of The Detroit Edison Co, was presented with the Washington Award on the evening of April 22 in Chicago. This award, made annually to an outstanding engineer, was conferred upon Mr. Cisler "for outstanding and continuing service to his country and mankind by making the world a better place to live through electric power."

Mr. Cisler delivered an address on The Electric Power Industry and the American Competitive Enterprise System.

The Washington Award is conferred by the members of the various national engineering societies, acting through the Washington Award Commission, of which John T. Rettaliata, president of the Illinois Institute of Technology was chairman, and also acting through the Western Society of Engineers. It is an honor conferred upon an engineer by fellow engineers.

H. C. McDANIEL has been named director of technical information for the Westinghouse Electric Corp. At the same time, Robert V. McGahey was appointed manager of technical publicity for the company.

Mr. McDaniel, formerly manager of technical information, will continue to supervise activities of both the technical publicity department and the Westinghouse *ENGINEER* magazine. In addition, he will provide technical assistance to the vice president of information services and will handle various special projects as assigned.

GAIL A. HATHAWAY, internationally known engineer, President of the International Commission on Large Dams, and Chairman of the American Committee at the World Power Conference in Vienna in 1956, was recently appointed Engineering Consultant, Department of Technical Operations of the World Bank.

Gail A. Hathaway

Mr. Hathaway was born in Wisconsin, served in the Army of France during World War I, and was graduated from Oregon State College in 1922 with a B.S. degree in civil engineering. In 1928 he was appointed an hydraulic engineer of the Army Corps of Engineers, and remained with them until his present appointment.

Since 1940 he has been recognized internationally for his work in hydrological engineering, and other problems relating to the planning, design and operation of flood control, navigation and multi-purpose projects.

CONSTRUCTION of the highest pressure, highest temperature chemical recovery boiler ever built for the Kraft pulping process is nearing completion in Hodge, La. It is a 300-ton recovery boiler for the Southern Advance Bag Operation of Continental Can Co's Robert Gair Division. Designed to operate at 1250 psi at the superheater outlet, with a final steam temperature of 900 F., the unit will generate 148,000 lb per hr of steam and will be capable of processing liquor resulting from the production of 300 tons per day of Kraft pulp.

3 dependable products for the diesel industry

DE LAVAL IMO PUMPS

De Laval IMO pumps do a dependable job during long years of service. The reason is IMO design simplicity. De Laval IMO's have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no reciprocating parts to wear or become noisy. Quiet, compact IMO pumps are excellent for direct-connected, high-speed operation. They can be furnished in capacities to 1,000 gpm and pressures to 1,500 psig.

DE LAVAL HYDRAULIC FAN DRIVES

De Laval Hydraulic Fan Drives for air cooled heat exchangers and cooling towers offer these important advantages. They *save* power since the fan operates at full speed only a portion of the time. They provide *accurate, automatic* control of engine jacket water temperature, and also assure complete operational flexibility. These units stay on the job for years. As shown, both IMO motor and speed reducer are mounted and factory aligned on a single bedplate.

DE LAVAL HIGH PRESSURE TURBOCHARGERS

De Laval turbochargers offer pressure ratios of 3:1 as well as higher compressor and turbine efficiencies than those found in conventional turbocharger systems. Output of heavy duty diesel, gas and dual-fuel engines may be doubled by De Laval turbochargers without increasing thermal loading. Exclusive Monorotor design offers a compact lightweight unit of sturdy construction. De Laval turbochargers are self-adjusting to engine loads, can be used on 4- *and* 2-cycle engines.

You'll find additional data in these De Laval Bulletins. Write for your copies.

DE LAVAL

Steam Turbine Company

TRENTON 2, NEW JERSEY

WHAT THEY TELL US

▶ **WE HIT THE BULL'S-EYE** according to E. L. C. Larson of Otter Tail Power Co, Minnesota, when we picked a shotgun as our grand prize for attendance at POWER ENGINEERING's Hospitality Suite in the Sherman Hotel during the recent American Power Conference.

Writing to Executive Editor Earle, grand-prize winner Larson said:

> The Grand Prize shotgun offered by POWER ENGINEERING at the American Power Conference arrived recently in perfect condition. Thank you.
>
> I wish to compliment you upon the selection of a Grand Prize so symbolic of our heritage of personal liberty. The ownership of this fine gun gives me a great deal of pleasure. . . .

Perhaps it is no coincidence that our acknowledgement of Mr. Larson's letter was being written at the precise day and hour — April 19th, between 9:30 and 10:00 A.M. — when "the shot heard 'round the world" was fired on a small wooden bridge in Concord, Massachusetts, 182 years ago. A nation can forget much in 182 years, and sometimes we think our nation has forgotten too much. But Mr. Larson hasn't forgotten.

Thanks, Mr. Larson, for reminding us.

▶ **MORE HELP** on the problem of painting a steel stack buff color, from Reader William J. Burns. For previous reference, see *What They Tell Us* on page 6, December 1956 and February 1957 issues. Problem is that the stack operates at 350 F, paint job must be guaranteed for three years, and the inquirer was doubtful he could do this because of the color. In the February issue, Reader Roop gave data on buff paint and a picture of his buff-colored stack. Now here's what Burns has to say:

> In my experience, Patterson-Sargent Co primer coats and finish paints have been used for a number of years with complete satisfaction for exterior and interior application to all types of power plant equipment, together with the enclosing and supporting structures.
>
> Regular paints have been found suitable for surface temperatures up to 200 F. Heat-resisting paints have been used for surface temperatures up to 300 F in a variety of colors for undercoats and finish paints. It is believed that the 200 F limit is conservative and that the same paints could be used for higher temperatures and possibly would be suitable for the stacks in question.
>
> For a recent plant, alkyd paints in various colors have been specified. These paints are expected to be suitable for surface temperatures up to 350 F. Zinc chromate primer has been used extensively in the past in all cases where temperature is a factor. For surface temperatures above 300 F and 350 F, high-heat silicone aluminum paint has been used with good results. This paint is obtained in black and grey, but the questioner doesn't want these colors.
>
> All of the above-mentioned paints should be applied to surfaces at normal atmospheric temperatures to obtain the best results.

Editor's Note: Patterson-Sargent Co's address on request.

▶ **IS YOUR PLANT SO BIG** that you can use a motor scooter for traveling around on it? Well, here's one that is!

Reader A. B. Donaldson of the Corps of Engineers at Bonneville Dam, Oregon, wrote in a letter to us:

> We need information about motor scooters for use in a power house and to travel over rough terrain.

Knowing the tremendous size of the Bonneville project, the editors can visualize what he has in mind. We sent him a list of manufacturers who can supply him with motor scooters. And in return, he is expected — if he gets the scooter — to write an article telling POWER ENGINEERING's readers how he uses it.

▶ **ONE OF OUR GOOD FRIENDS** and readers, also a contributor to POWER ENGINEERING, has asked for help in obtaining information regarding availability of a diaphragm-controlled adjustable relay or switch to operate the tripping mechanism of a motor driving an oil pump under the following conditions:

He has a screw-type fuel oil pump driven by a 100-hp induction motor, pumping oil through about 1000 ft of 8-in. pipe to a 1,000,000-gal fuel tank on a hill. Total head about 150 ft. There is a hand valve at the base of the tank, which will be locked open with a padlock; and there is a check and another hand valve at the pump discharge which will be closed when not pumping,

To prevent excess pressure in the pump should the operator start the pump before opening the valve, and also to trip the motor out when the tank is full, at a definite pressure, and so avoid overflowing, he thought he might put in a diaphragm-controlled device to operate the tripping mechanism of the motor and stop the pump. The working pressure on this diaphragm will be around 300 psi; the voltage, 110; and the current, whatever is necessary to operate the trip mechanism.

We have passed along this request to manufacturers of pressure switches and tripping devices. This seems to be the simple and logical solution to the problem. However, if readers have any further suggestions or comments on it, they will be most welcome. Write to *What They Tell Us*, POWER ENGINEERING, 110 S. Dearborn St, Chicago 3, Ill.

▶ **AUTHOR UNKNOWN** — When Reader Leslie H. Housel of Jackson, Mich. sent us the following information, he said the author was unknown, but he hoped that we might have a spot for it . . .. and here's the spot, directly below:

How To Be An Unregistered, Unloved, Unprofessional, Professional Engineer

1. Do not check through a job; take a chance, you may guess right.

2. Draw attention away from yourself by criticizing all other departments.

3. Don't do anything to advance your job knowledge or education; they may pick you for a promotion anyway.

4. Be sure to let everyone know that you are handling the toughest project; they may believe you.

5. When another section or department is involved in your work, keep the information away from them. Let's see if they have any of the Sherlock Holmes in them.

6. Put in many early complaints on your project so that, when the roof falls in, everybody will surely know that you are blameless.

7. Try to handle work that has been delegated to other departments; they may know more about it and will get it right, but this will be a diversion for you.

8. Never concede that anyone else can handle part of your work. Instead, modestly state that you want to do it yourself, so that you may be certain it is done right.

9. Why should you help the young fellows develop? No one helped you; you were born with your talent.

10. In spite of what is generally believed — that everyone notices the man who is giving an excellent individual effort — frequently remind all within hearing distance how busy you are, and that it is an insupportable burden you are carrying.

One of a series.

Some Things to Think About Steam Traps

...in order to get high operating efficiency and a minimum of maintenance

The gentleman who invented the wheel had a basic idea and so far no one has come up with anything better for the purpose.

If you'll pardon us for a little overemphasis on the significance of steam traps, we'd like to liken one of them to the wheel.

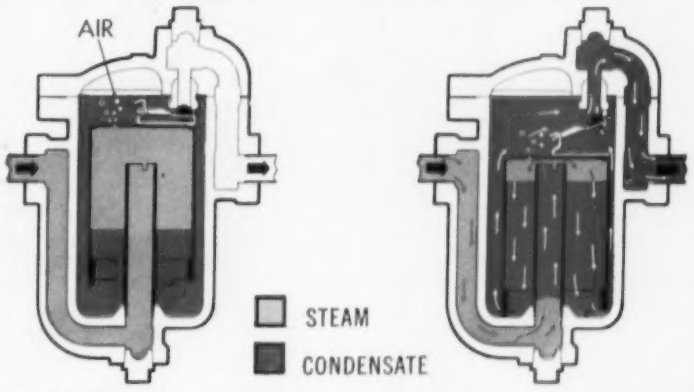
In 1911, when the first Armstrong inverted bucket steam trap model was announced to the world, or at least that part of the world that modest advertising and sales budgets would cover, it was not received with equal enthusiasm by all (especially old-style trap makers). But, like the wheel, it managed to find its way into general use. And, nothing better has ever turned up for the purpose of draining condensate. As a matter of fact, the Armstrong trap has been very widely copied. Today, there are more inverted bucket traps draining process equipment than any other kind. Of these, there are more Armstrongs.

If this sounds like the boasting of a proud parent, give consideration to some fundamental requirements not met by all traps:

1. ***A steam trap should not leak steam.*** Some traps do, you know, because of the nature of their operating principle. No steam ever gets to the Armstrong trap orifice. The valve is always water sealed.

2. ***A steam trap should vent "air" as fast as it accumulates***—otherwise temperatures are reduced and corrosion is a problem. The Armstrong trap handles air very nicely. The vent in the bucket permits air to accumulate in the top of the trap, from where it is discharged when the trap opens. For extreme conditions like draining paper machine dryers, some jacketed kettles and certain other units, the vent is sized larger for the job. And, for handling big volumes of air during warm-up, a bucket with an auxiliary thermic vent really speeds up heating.

3. ***A steam trap should discharge condensate at steam temperature*** if you want to get maximum efficiency from the unit drained. And most people certainly do. If you have to wait for the condensate to cool, it's almost impossible to maintain maximum temperatures and prevent air build-up. You guessed it—the Armstrong trap opens for water, without dependence on temperature.



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

4. ***A steam trap should be suitable for any return system.*** The Armstrong trap works just the same whether discharging to atmosphere, back pressure or vacuum. It has been conclusively proved that flash steam resulting from use of a bucket trap does not cause a problem in vacuum return systems. The flash condenses rapidly. It's the leaky traps that cause the headaches.

5. ***A steam trap should not be a "prima donna".*** Some kinds of traps take an awful lot of care and coddling. The Armstrong trap is a rough and ready type with a hardened chrome steel constitution (valve and seat, to be exact). It cleans itself of ordinary dirt and scale without choking up. Its 18-8 stainless parts stave off rust and corrosion. It resists wire-drawing and wear remarkably well. In fact, it stays on the job longer with less attention than any trap ever produced. Unless you live in Siberia, you can probably find a user around the corner who will tell you so from experience.

6. ***A trap should not be an "orphan".*** With Armstrong traps you can *always* get prompt service and parts from nearby Factory Representatives and stocking distributors as well as from the factory.

7. ***A trap should have a guarantee.*** The Armstrong trap is unconditionally guaranteed to give you *complete satisfaction* (as to doing its job, that is). If it doesn't, you can get your money back.

If you'd like to buy some of these excellent steam traps, call your local Armstrong Representative or write **Armstrong Machine Works, 8106 Maple St., Three Rivers, Michigan.**

ASK FOR the 44-page Steam Trap Book, free on request without obligation.

ARMSTRONG STEAM TRAPS

For more data circle 505 on Post Card

Here's why your best steam trap buy is Yarway Impulse

THERE'S A YARWAY IMPULSE STEAM TRAP FOR EACH OF THESE REQUIREMENTS

As shown opposite, no matter what your need—normal loads, high capacity, low capacity, high pressure, low pressure—Yarway has an *impulse* trap to meet it.

GETS EQUIPMENT HOT FAST—KEEPS IT HOT

Yarway pioneered the application to steam traps of the principle of thermodynamics that makes possible quick heat-up, and high, steady temperatures. Result—peak efficiency from equipment.

ONLY ONE MOVING PART

A little valve is the only moving part. Nothing could be simpler.

LOW MAINTENANCE

Design and material make Yarway Impulse Traps practically trouble-free. A handful of spare parts will service a plant-full of traps.

SMALL SIZE . . . LIGHT WEIGHT

Fit in anywhere. Require no supports or special piping.

GOOD FOR ALL PRESSURES

No change of valve or seat for any pressure up to specified maximum.

NON-FREEZING

Great for outdoor installations. Won't freeze up, because condensate can't accumulate—there's nothing to freeze.

LOW COST

It often costs *less* to install a new Yarway Impulse Trap than to repair a conventional-type trap.

CONVENIENT SUPPLY

Over 270 Industrial Distributors stock and sell Yarway Impulse Steam Traps. One is near you.

NATION-WIDE SERVICE

34 trained Yarway field engineers, located in every corner of the country, give you quick, helpful steam trap service.

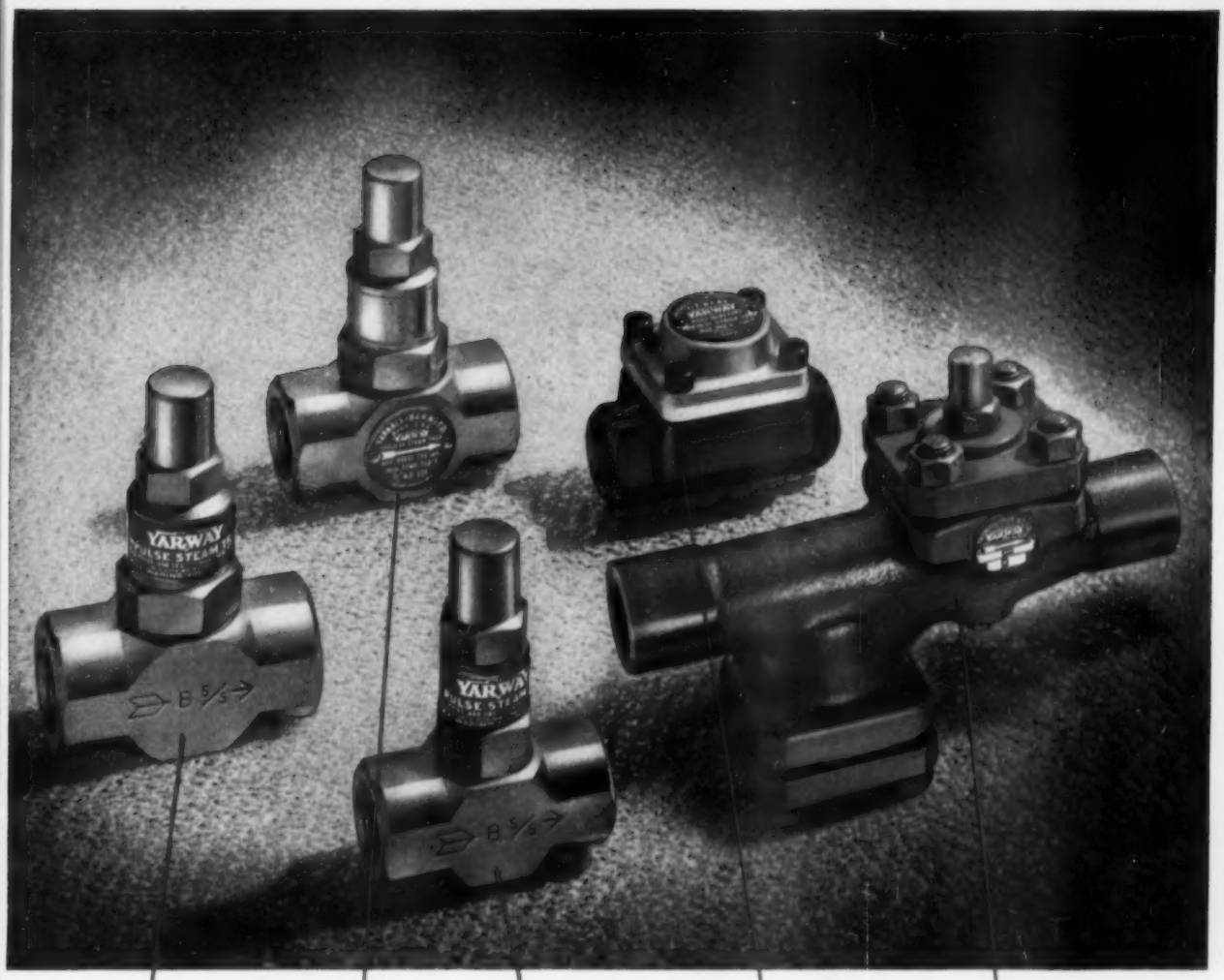
Want the free booklet "Banish Your Steam Trap Troubles" . . . or the Yarway Trap catalog? Write

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.

Cross section of Yarway Impulse Steam Trap showing the only moving part, a small stainless steel valve. It actually floats on the condensate load.

more than a million sold!

YARWAY *impulse*® ...a good



CHOOSE THE RIGHT IMPULSE STEAM TRAP FOR YOUR JOB

NORMAL REQUIREMENTS

Use Yarway Series 60 traps. All pressures to 400 psi and temperatures to 450°F. Six sizes ½" to 2".

HIGHER PRESSURES AND TEMPERATURES

Use Yarway Series 120 traps for pressures to 600 psi and temperatures to 750° F. Six sizes ½" to 2".

LIGHT LOADS

Use Yarway No. 20-A trap where condensate loads are especially light. (Available only in ½" size.)

HEAVY LOADS

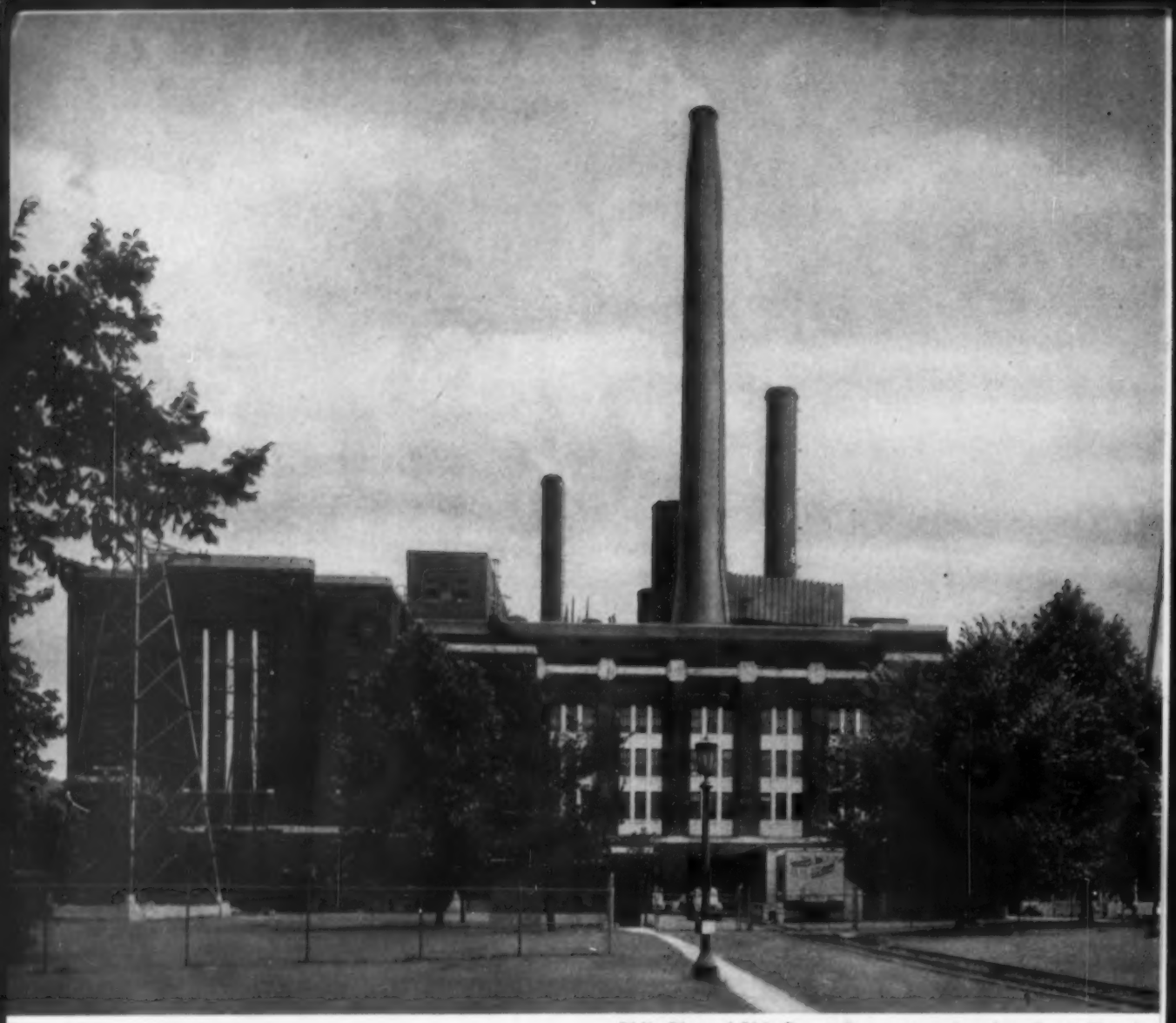
Use Yarway Series 40 traps where condensate loads are especially heavy. Five sizes, ½" to 2½".

INTEGRAL STRAINER

For high pressure power plant trapping, also marine use, specify Yarway Integral Strainer Traps. Welding or flanged connections.

way to specify steam traps

For more data circle 506 on Post Card



Philo Plant of Ohio Power Company on American Gas & Electric System. Stack in front is for the new Supercritical Unit.

B&W's Universal Pressure Steam Generator

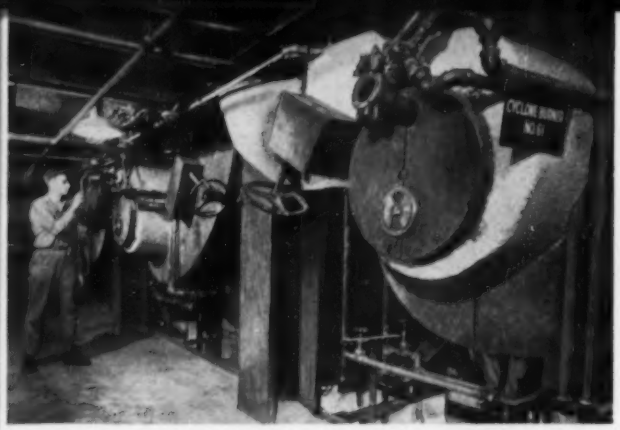
Helps Philo Plant Open the Way to New Economies in Steam-Electric Generation

Generating history is being made at the Philo Plant of the Ohio Power Company on the American Gas & Electric System. Here, America's first commercial supercritical pressure steam-electric unit is in operation, probing the frontiers for new economies in the production of energy.

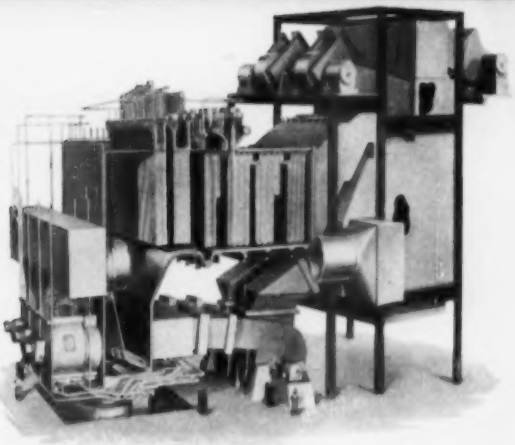
A Symbol of the Vision and progressiveness of America's public utilities and their suppliers, Philo is a landmark in engineering history. It is the result of years of engineering, research, and development that solved the many problems which had stood in the way of greater plant efficiency that comes with the highest possible combination of pressure and temperature.

The Problems Solved included the very difficult ones of feedwater chemistry, of heat transfer and control of internal deposits, metallurgy for higher temperatures combined with higher pressures, and development of control and operating techniques.

Philo's Supercritical Unit, with a turbo-generator operating at 4500 psi and 1150F, is producing over 120,000 kw, in the same space and using 45 per cent less fuel per kwhr than the 40,000 kw unit it replaced.

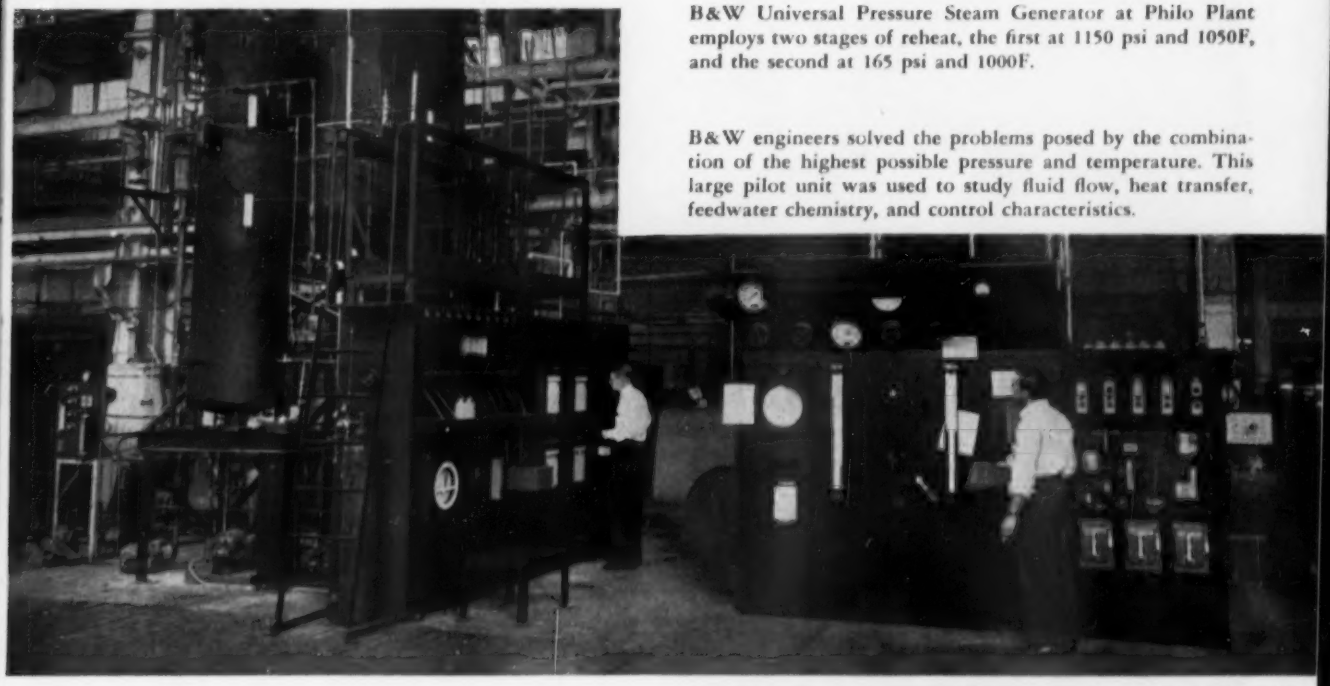


Three B&W Cyclone Furnaces assure rapid and complete combustion, with minimum fly ash discharge and maintenance.



B&W Universal Pressure Steam Generator at Philo Plant employs two stages of reheat, the first at 1150 psi and 1050F, and the second at 165 psi and 1000F.

B&W engineers solved the problems posed by the combination of the highest possible pressure and temperature. This large pilot unit was used to study fluid flow, heat transfer, feedwater chemistry, and control characteristics.



Two More B&W Universal Pressure Steam Generators are now being built for The American Gas & Electric System. Together these will produce 900,000 kw—enough to supply residential power for a city of 8,000,000. Like Philo, they will continue to push forward this new frontier in steam generation.

Nearly a Century of B&W leadership in steam generation stands behind these achievements. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-833-CS

BABCOCK & WILCOX

BOILER DIVISION

Shop assembly of secondary front wall. Pre-assembly of many components for the Universal Pressure Steam Generator greatly speeded field erection.

For more data circle 507 on Post Card

"On a low voltage situation, Fusetron dual-element Fuses opened and warned us of the need for a larger transformer"

HERMAN BOND, PRES.
ACME ELECTRIC CO., DENVER, COLO.

Here's Mr. Bond's own story of how Fusetron fuses helped solve the low voltage situation.

"A flock of Fusetron dual-element fuses blew one afternoon at the Duffy Bottling Works several weeks after we had completed changing the entire plant to this type of fuse in an effort to eliminate extreme heating in switches and to get more dependable protection.

"Before putting the circuits back in operation we wanted to find out what had caused the Fusetron fuses to open.

"On checking, we learned that a severe voltage drop occurred whenever the plant was in full operation. The trouble was due to the transformer being too small to keep the voltage at its normal value of 220 volts.

"To prevent the trouble recurring, a larger transformer was installed. Since then, they have had no more low voltage difficulty.

"By opening and warning of the need for a larger transformer, Fusetron fuses not only saved Duffy Bottling Works the expense of possible motor burnout, but also prevented costly slowdowns in their production."

You too, can save money throughout the plant by using Fusetron fuses . . . ***They Provide 10 Point Protection*** ***1.*** High interrupting capacity —protect against short circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes. ***2.*** Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation. ***3.*** Protect against needless blows caused by harmless overloads. ***4.*** Provide thermal protection—for panels and switches against damage from heating due to poor contact. ***5.*** Protect against waste of space and money—permit use of proper size switches and panels. ***6.*** Project motors against burnout from overloads. ***7.*** Give DOUBLE burnout protection to large motors—without extra cost. ***8.*** Protect motors against burnout due to single phasing. ***9.*** Make protection of small motors simple and inexpensive. ***10.*** Protect coils, transformers and solenoids against burnout.

DON'T RISK LOSSES! One lost motor . . . one needless shutdown . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing every ordinary fuse with Fusetron dual-element Fuses. *Write for Bulletin FIS.*

FOR LOADS ABOVE 600 AMPS.—USE BUSS HI-CAP FUSES to coordinate your electrical circuits.

On 600 volts or less, BUSS Hi-Cap fuses have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuits of origin. Write for Bulletin HCS.

BUSSMANN MFG. CO. (Div. of McGraw-Edison Co.)
University at Jefferson, St. Louis 7, Mo.

Play Safe! install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

For more data circle 508 on Post Card

ERIE CITY STEAM

The 650 Acre Fortier Plant of American Cyanamid on the Mississippi River near New Orleans, Louisiana

THIS $50,000,000 PLANT

Processes Natural Gas, Air, Water and Sulphur to produce a variety of Petrochemical Products, most important of which is Acrylonitrile, basic to farm and industry

Dependability is the keystone of petrochemical processing, and that is why we are proud to have Erie City steam generators selected for this important operation. Cyanamid's Fortier Plant gets its natural gas from the abundant Louisiana oil fields, its water from "ole man river" and its process steam from three Erie City 200,000 lbs./hr. steam generators.

Erie City has over forty years experience with 2-drum boilers gained in hundreds of installations. The basic 2-drum design, pioneered by Erie City, has been modified in a compact design to incorporate a completely water cooled furnace as an integral part of the main circulation system. Heavy refractory furnace linings are thus eliminated and continuously high ratings can be carried. Erie City 2-drum boilers permit wide flexibility, quick response to load changes and produce steam of high quality.

Erie City designs and manufactures all major components of its broad line of steam generators and offers undivided responsibility. For concise information about the complete line, ask for Bulletin SB-503F.

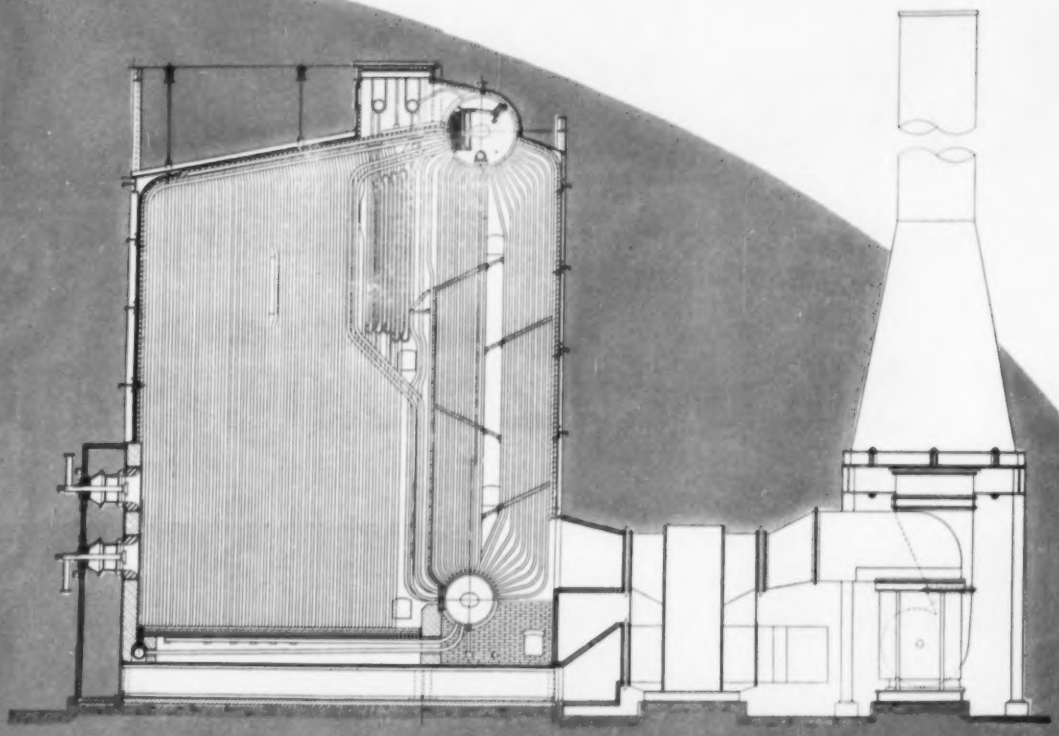
ERIE CITY
117 Years in Steam Generation

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

- - - powers processing at FORTIER PLANT, New Orleans, La.



BOILER DATA:

BOILERS—2-DRUM

3 Erie City~

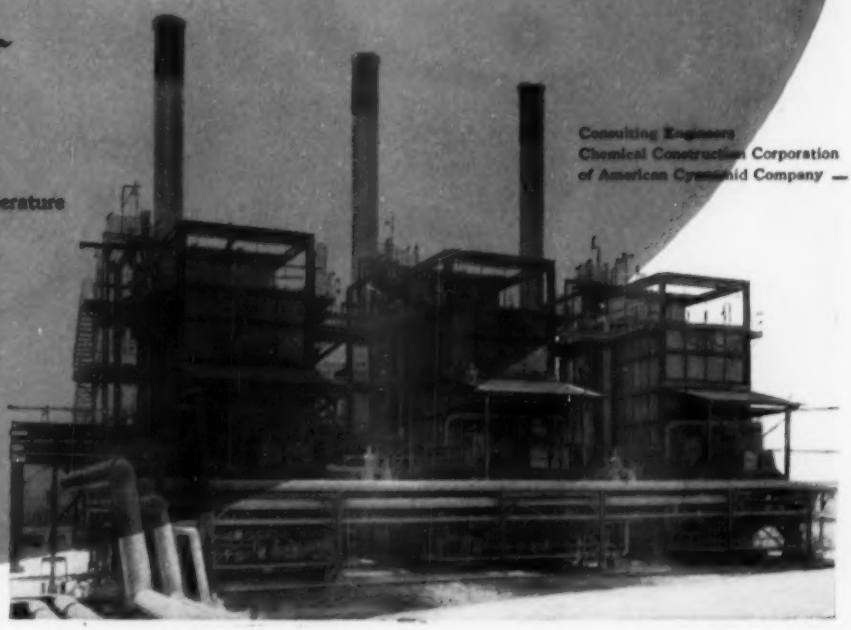
200,000 lbs./hr.

- Design Pressure
  700 psig
- Total Steam Temperature
  750° F.

SUPERHEATERS—

E. C. PENDANT

Consulting Engineers
Chemical Construction Corporation
of American Cyanamid Company —

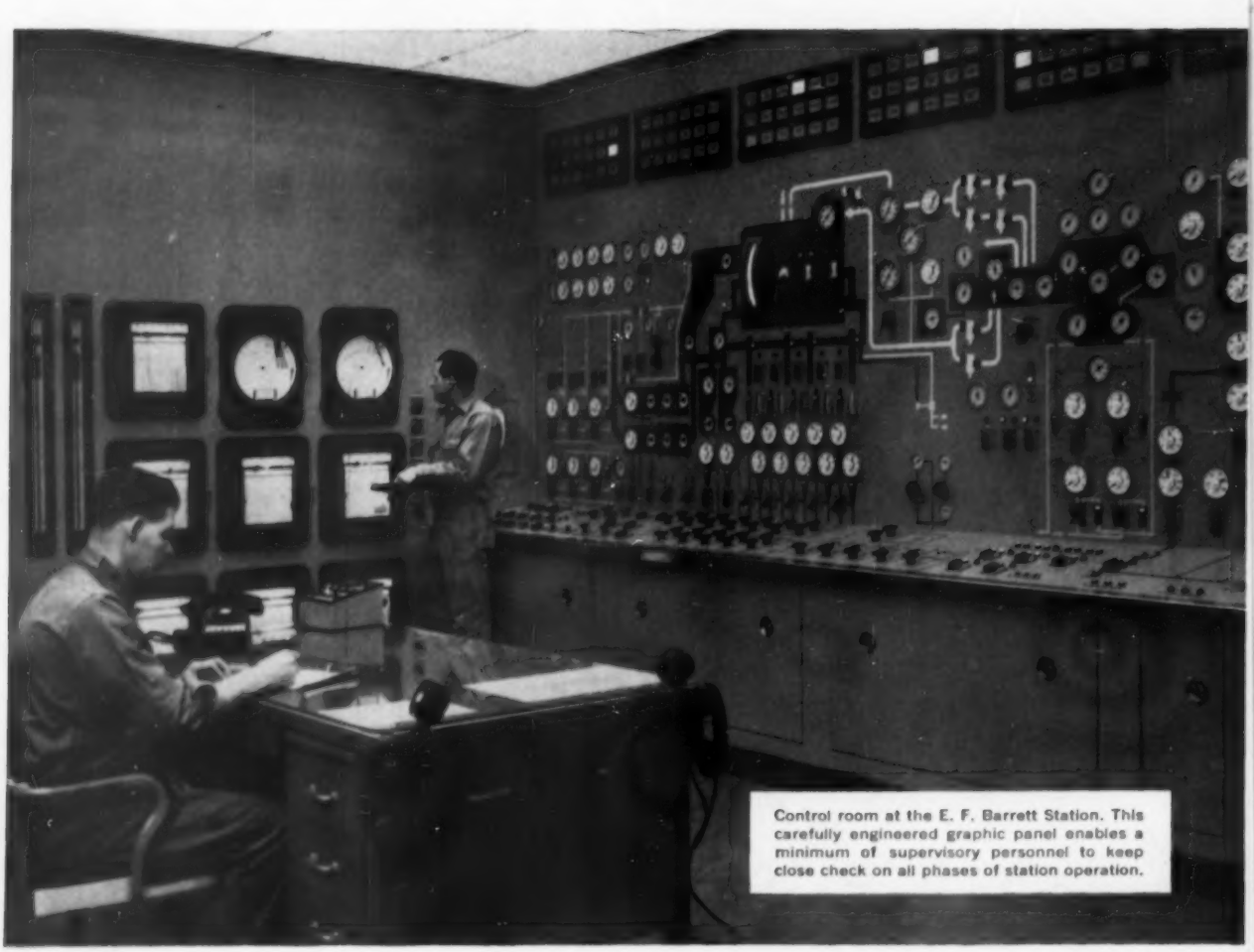


For more data circle 509 on Post Card

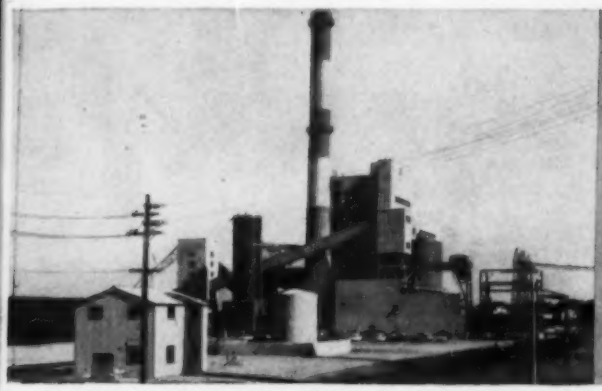
The E. F. Barrett Station, completed in 1956. This station has Hagan combustion control, three-element feedwater control, and primary metering. Designed to take full advantage of the latest construction techniques, a major part of the station is outdoors, following the pattern established at the Port Jefferson Station.

The Port Jefferson Station. Unit No. 1 (1949) has Hagan combustion control, as does Unit No. 2 (1950). Unit No. 3 will be equipped with Hagan Combustion Control, three-element feedwater control, and primary metering. The feedwater control system will include Hagan compensated drum level control.

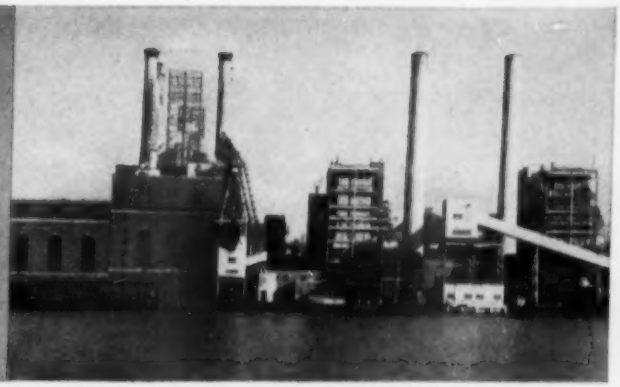
since 1942—Long Island



Control room at the E. F. Barrett Station. This carefully engineered graphic panel enables a minimum of supervisory personnel to keep close check on all phases of station operation.



Long Island Lighting Company's Station at Far Rockaway. This station went into commercial operation in 1954. It has a Hagan combustion control system. All of the stations, with the exception of Port Jefferson, are equipped with Hagan Remote Switching, providing a short direct signal path from controller to positioner.



Glenwood Station. Here Hagan has a long history. The first Hagan combustion control system was installed on Boiler #5 in 1942. Since then the record runs as follows: 1946—Boiler No. 6, 1952—Unit No. 4, 1954—Unit No. 5. Units No. 4 and No. 5 fire a combination of pulverized coal with oil or gas.

Lighting chooses HAGAN

Performance is the reason why Long Island Lighting Company now has Hagan combustion control systems on seven boilers, with an eighth on order. The last two of these are also equipped with Hagan three-element feedwater control. Management, engineers, and operating personnel alike have found that the simple, sturdy construction, high accuracy, and reliable operation of Hagan equipment contribute materially to station efficiency.

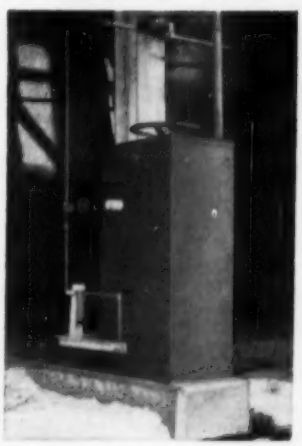
Hagan operating units perform well out-of-doors, and Hagan remote switching provides fast response to changing steam demands. Hagan three-element feedwater control includes drum level compensation which permits accurate indication and automatic control of drum level, even during start-up and shutdown.

Long Island Lighting Company is one of the nation's fastest growing utilities. The first installation of Hagan equipment was an automatic combustion control system for the #5 boiler at their Glenwood Station. On their newest unit, the very modern 180 Mw. E. F. Barrett Station, Hagan systems include automatic combustion control, three-element feedwater control, and metering.

Hagan's 39 years of experience in the design and manufacture of automatic controls for all types of boilers provide a unique background for the solution of control problems. A Hagan representative will be glad to discuss your requirements.

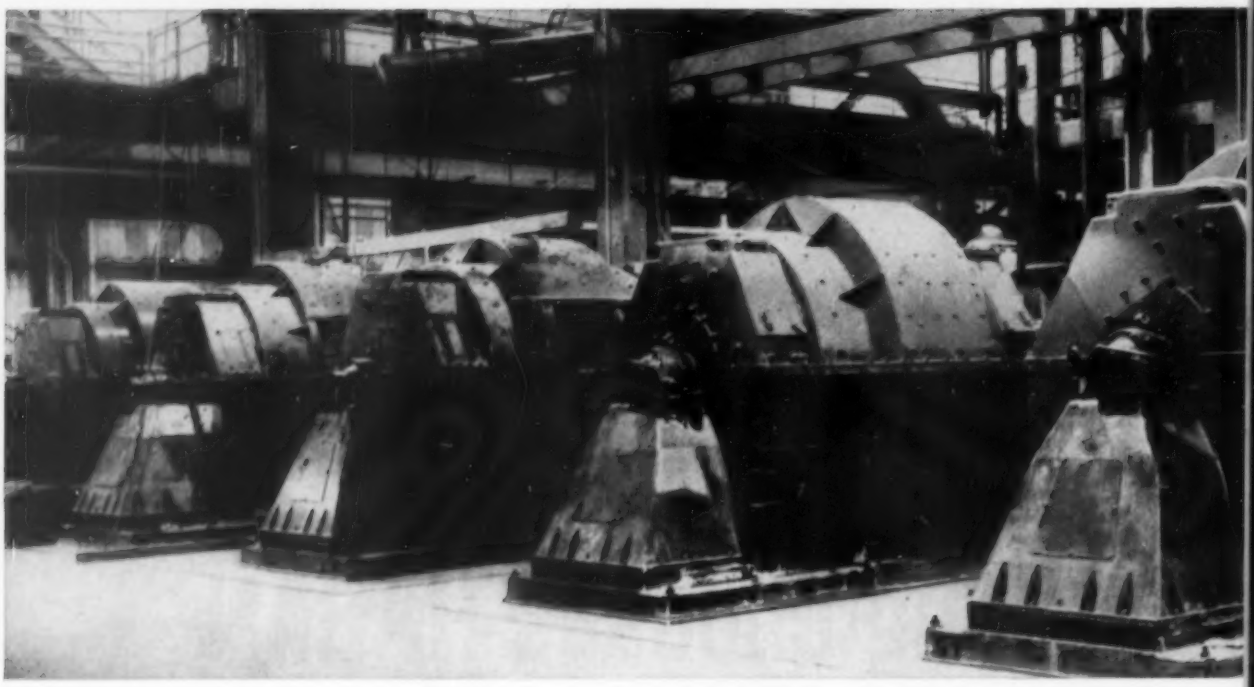
HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY • HALL LABORATORIES



Hagan Power Positioner for induced draft fan discharge dampers. The fully-enclosed Power Positioner is designed to provide accurate, reliable positioning, whether indoors or outdoors. Station operators are particularly pleased with the integral locking feature of the Hagan Power Positioner.

For more data circle 510 on Post Card



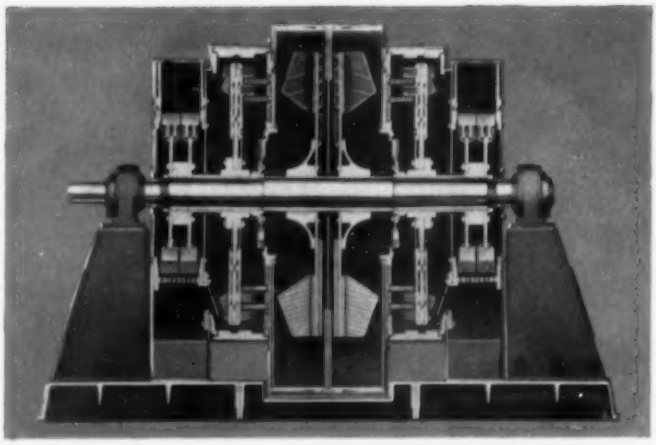
Six Riley Pulverizers

Other Riley 550 Duplex Pulverizers have been installed in central stations of these public utilities.

Columbus & Southern Ohio Electric Co.
Picway — 4 Units
Public Service Co. of Colorado
Denver — 11 units
Iowa-Illinois Gas & Electric Co.
Davenport, Iowa — 1 unit
The Potomac Edison Co.
Albright, W. Va. — 3 units
Monongahela Power Co.
Albright, W. Va. — 3 units
Delaware Power & Light Co.
Delaware City, Del. — 9 units
Iowa Public Service Co.
Waterloo, Iowa — 2 units

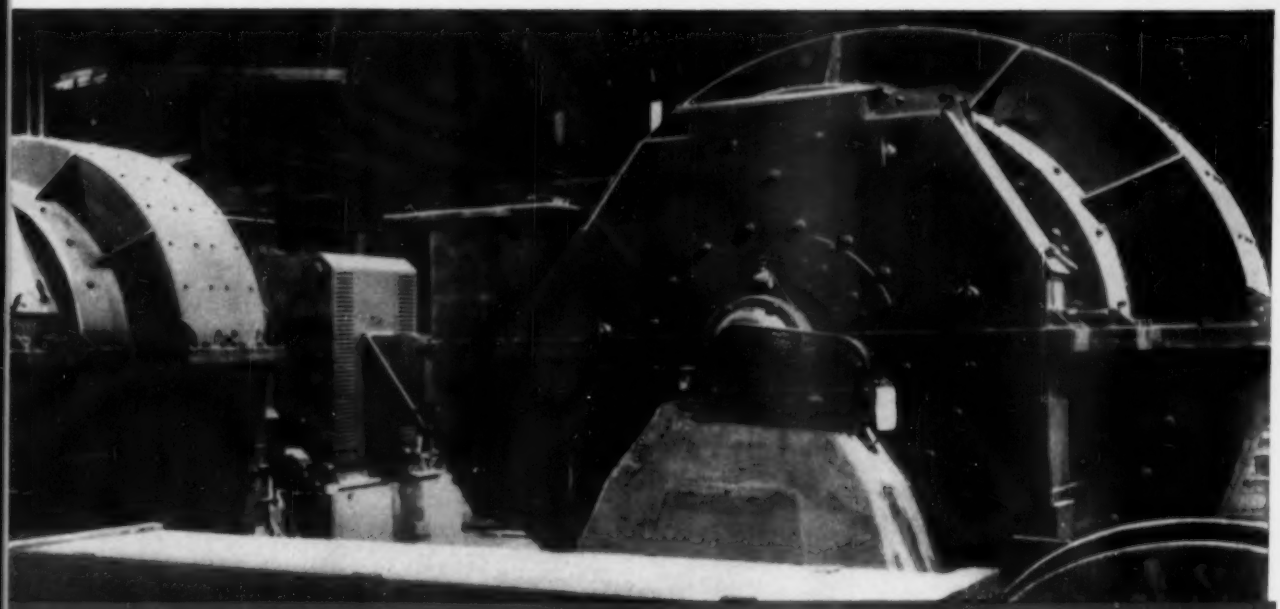
A few 550 and 450 Pulverizer Public Utility Installations

Utah Power & Light Co., Gadsby — 4 units
Northern States Power Co.,
Granite Falls, Minn. — 3 units
The Hartford Electric Light Co.,
Middletown, Ct. — 8 units
Iowa Electric Light and Power Co.,
Marshalltown — 6 units
Boone — 3 units
Taiwan Power Co., Formosa — 3 units
Upper Peninsula Generating Co.,
Marquette, Mich. — 2 units
Interstate Power Co.,
Lansing, Iowa — 2 units
Minnesota Power & Light Co.,
Duluth — 4 units



Some of the Outstanding Advantages of Riley Pulverizers

Tungsten carbide faced pulverizing parts
No metal to metal contact
Quiet, vibrationless operation
Small overall space
Low foundation cost
No loss of capacity with wet coal
Extreme load range
Insignificant Btu loss with rejections
Insignificant handling cost of rejections
Ease of maintenance and service
No adjustments required to maintain fineness
Low cost maintenance with high ash coals
Ability to use high primary air temperature with increase in efficiency
Minimum of lubricating difficulty
Ease of automatic regulation
No auxiliary air required for sealing
Minimum explosion and fire hazard
Rapid response to load change



will pulverize 115 tons of coal per hour at River Rouge Plant of Detroit Edison

When the huge new 2,000,000 lbs/hr boiler at Detroit Edison's River Rouge Plant goes on the line these six Series E Riley Duplex Pulverizers, capable of pulverizing up to 138 tons of high fineness pulverized coal per hour, will provide more than enough capacity for the 114.5 tons per hour required by the huge boiler. Among their many desirable features will be quiet, vibrationless operation. Operating without metal-to-metal contact, pulverizing pegs, mounted on a huge rotating discs, will shatter coal particles against stationary pegs reducing coal by attrition to a high degree of fineness, and will sustain this fineness indefinitely. Tungsten carbide is applied to the facing of pegs to help reduce effects of erosion, and to prolong availability.

Riley is proud that the performance of its Pulverizer merited its selection for such an important role in Detroit Edison's expansion program, a program largely dedicated to the search for better and more efficient steam generation from coal.

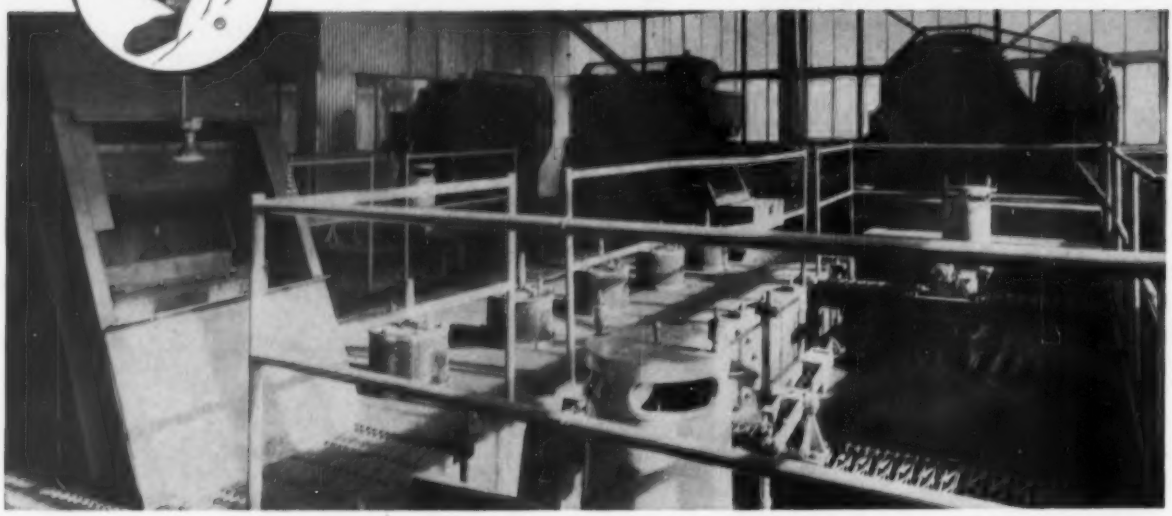
A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 511 on Post Card

WHY CHESSIE'S RAILWAY IS FIRST IN COAL



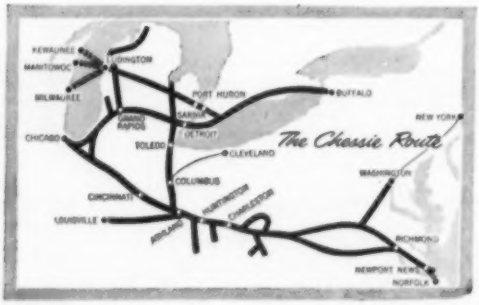
SUPERIOR COAL. The entire output of this mine is processed by automatic compound coal cleaning equipment. Producers on the Chesapeake and Ohio are prepared to supply you with highest quality coal of the type best suited to your needs and processed to your own specifications.

SUPERIOR SERVICE. To its present fleet of 63,780 coal cars—largest in the world—C & O is adding another 8,000. New high-speed yards, new locomotives and a new teletype car reporting system bring you faster, more dependable service.

For dependable deliveries of top quality coals, contact coal producers on the C & O. And for specific help in meeting your own fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

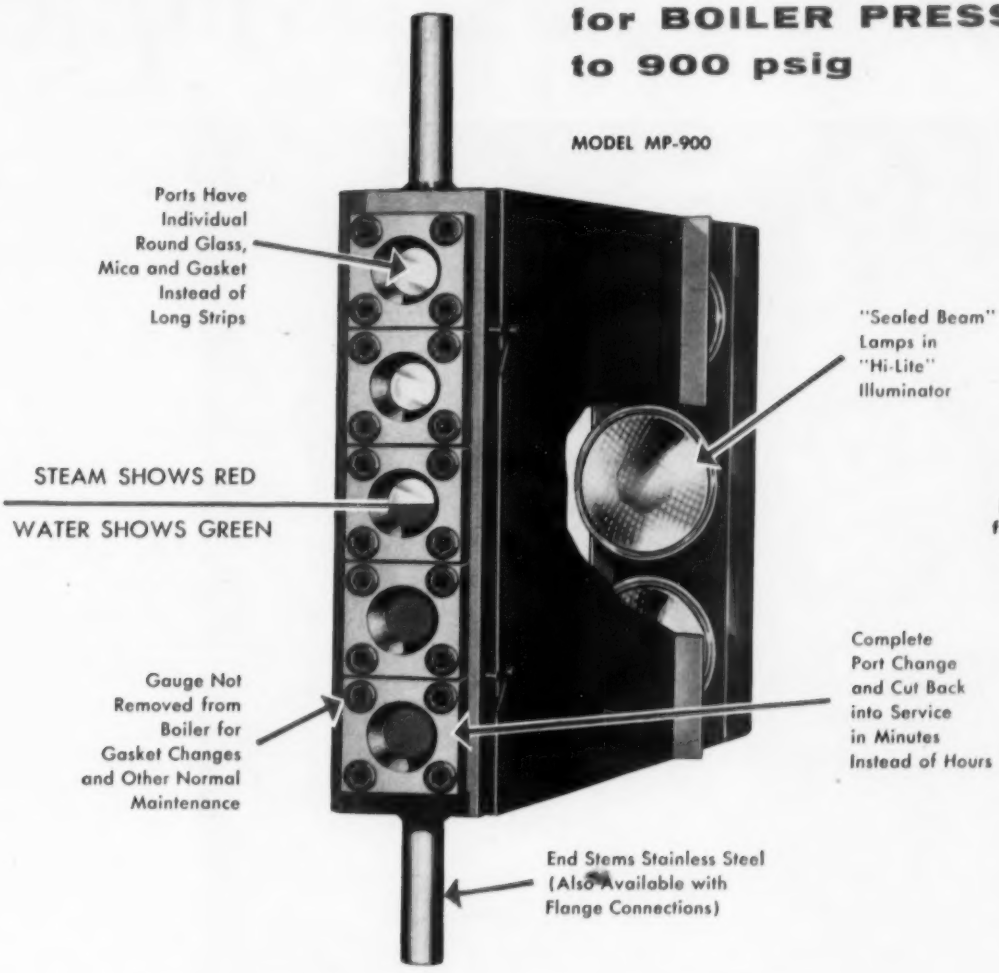


For more data circle 512 on Post Card

Sure-Reading ...DIAMOND "Multi-Port" Bi-Color Gauge

for BOILER PRESSURES to 900 psig

MODEL MP-900


Ports Have Individual Round Glass, Mica and Gasket Instead of Long Strips
"Sealed Beam" Lamps in "Hi-Lite" Illuminator
STEAM SHOWS RED
WATER SHOWS GREEN
Also available is Model MP-3000 for boiler pressures to 3000 psig
Complete Port Change and Cut Back into Service in Minutes Instead of Hours
Gauge Not Removed from Boiler for Gasket Changes and Other Normal Maintenance
End Stems Stainless Steel (Also Available with Flange Connections)

The individual round ports each having its own round glass, round mica and round gasket (instead of the conventional long strips) means less stress and strain . . . resulting in greatly reduced maintenance. When replacement is required, it is usually only one port . . . which can be changed in a very few minutes . . . and without removing the gauge from the boiler.

The Diamond Bi-Color feature is another important advantage of the MP-900 Multi-Port . . . steam always shows red and water always shows green. There can be no question of the water level.

Recommended for both new and old boilers up to 900 psig, the MP-900 Multi-Port will give you a new standard of gauge operation. Use the coupon below for additional information.

7757

DIAMOND POWER SPECIALTY CORP. AB
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 2044 explaining the advantages of the Diamond MP-900 "MULTI-PORT" Bi-Color Gauge for all boiler operating pressures up to 900 psig.

NAME_____

COMPANY_____

ADDRESS_____

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

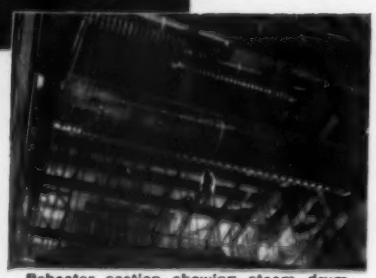
For more data circle 513 on Post Card

Progress Report

2,000,000 lb/hr

View looking upward in the reheater section, showing the 126-ton steam drum being raised into position. Shipped completely fabricated from Foster Wheeler's Mountaintop, Pa., plant, the first of the two steam drums arrived on the job-site on May 28, 1956 and was raised into position on June 1st.

Reheater section steam drum suspended in approximate position for final location, viewed from upper level.



Reheater section showing steam drum, headers and hangers in place, looking upward from 7th floor level.

on World's First

STEAM GENERATOR

Record-shattering FW steam generator for Detroit Edison's River Rouge Plant will deliver 8,620 btu per kwhr for 320,000 kw Unit No. 3

THE first steam generator ever designed to produce 2,000,000 pounds of steam per hour is now well under construction at Detroit Edison's River Rouge Plant. This huge FW steam generator, for 320,000 kw Unit No. 3, will also be one of the most efficient and economical units ever built. With a heat rate of 8,620 btu per kwhr, it will produce a kilowatt of electricity from less than ¾ lb of coal!

Designed for a pressure of 2700 psi, with 2450 psi and 1050F at the superheater outlet, it includes reheat facilities for resuperheating the steam to 1000F after it has passed through the initial stages of the turbine.

This single-unit FW steam generator consists of two separate sections, each containing a radiant superheater. All of the convection superheater surface is located in the "superheater section" and all of the convection reheater surface, in the "reheater section." Firing of the reheater section furnace is controlled to maintain 1000F reheat steam temperature, while the superheater section furnace is fired to maintain primary steam pressure. Primary steam temperature of 1050F is controlled by condenser-type desuperheaters.

The photographs included here show progress in the erection of this history-making FW steam generator at the River Rouge plant. This outstanding installation is another example of Foster Wheeler's ability to meet the most exacting requirements of modern power plant operation. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

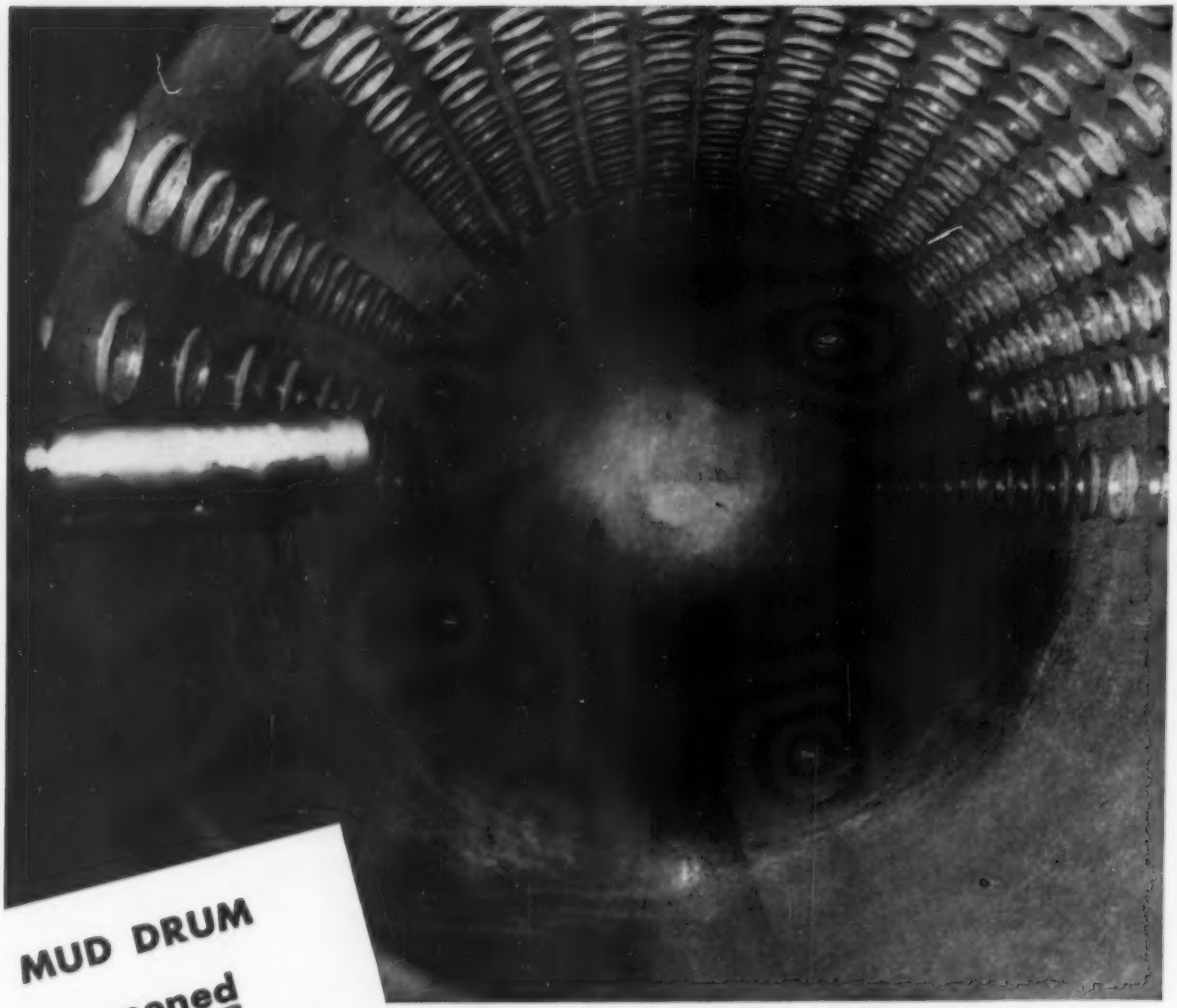
NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

View of economizer space of the superheater section, looking downward from the 9th floor level.

Reheater section economizer, also viewed from 9th floor elevation during construction.

Foster Wheeler's Construction Superintendent H. A. Shouse and Field Materials Coordinator A. K. Broome inspect radiant wall tiebacks.

For more data circle 514 on Post Card



MUD DRUM
as opened
after one year
on line
with
THE *Nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

NATIONAL ALUMINATE CORPORATION
Telephone: POrtsmouth 7-7240
6224 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

For more data circle 515 on Post Card

HELPFUL BULLETINS

ELECTRICAL

101 Induction Motors — Bulletin GEC-1420 contains application data on drip-proof and enclosed polyphase induction motors, 1-5 hp; frames 182-215; 208-220/440, or 550 v; 60 cycles. It includes charts showing single-speed ratings and frame sizes, typical speed-torque curves, starting torque values, and starting and full-load currents. Cutaway views are included. General Electric Co.

102 Single-Phase Motors — Bulletin GEA-6240A, 8 pp, illustrates specific advantages of single-phase capacitor type motors, 1-3 hp, 115/230 v, 60 cycles, for materials handling, wood- and metal-working equipment, pump and compressor, fan and blower, refrigeration and air conditioning, and other applications. Dimension data for estimating is given on drip-proof, resilient-base, and totally enclosed fan-cooled motors. Rating and type charts are included. General Electric Co.

103 Instrument Transformers — Catalog GEC-1028B is an 86-pp buyer's guide to instrument transformers. Designed to save time in selecting and ordering company's current transformers, potential transformers, and metering outfits, it supplies pertinent data, including prices, on all standard types. In addition, information is supplied on accuracy, insulation, strength, application, thermal conductivity, etc. Complete information can readily be obtained from leaflets on individual types, references to which are made in the text. Data is presented in convenient tabulated form, fully illustrated with photos. General Electric Co.

104 Transformer Maintenance Hints — Fifty-pp, pocket-size Booklet B-4716-B provides "timely tips on transformer maintenance." Discusses transformers and their maintenance and includes such subjects as general inspection procedures, classification of transformers, methods of drying out, and transformer connections. Text is concise and illustrated with photos, drawings and diagrams. Westinghouse Electric Corp.

105 On Instrument Transformers — This 24-pp-booklet discusses theory and operation of instrument transformers. Deals with metering applications and gives examples of connections. Presents many ASA standards in easy reference form and shows typical current and potential transformer performance curves. A handy ratio-phase correction chart is included. Allis-Chalmers Mfg. Co.

106 Specialty Transformers — Bulletin GEC-1431 describes dry-type specialty transformers for general light and power service. Gives application, price, new dimension and model number data, and wiring diagrams on dry-type specialty transformers 600 v and below, 60 cycles, commonly used to reduce voltage of 240-v, 480-v, or 600-v circuits to supply 120- or 240-v loads. General Electric Co.

107 Core-Coil Replacement — Ease with which company's transformer core and coil assemblies can be used for replacement purposes is told in Bulletin 61B6345B. They are available in 3 kva through 25 kva and in high voltage ratings 2.4 kv through 15 kv. Bulletin also includes mechanical information on the replacement core and coil assemblies. Allis-Chalmers Mfg. Co.

108 Oil Circuit Recloser — Sixteen-pp Bulletin CR1W describes company's 200-mva Kyle Type W oil circuit recloser. Contains information on application, operating features, design features, ratings and possible modifications. Dimensions and ordering information are furnished. Graphs, charts and tables are provided, including time-current curves, duty cycle, interrupting and load ratings as well as complete specifications. Line Material Industries, McGraw-Edison Co.

109 Plug-In Busway — Bulletin GEC-1446, 8 pp, describes a combination feeder, plug-in busway rated from 600 to 4,000 amp, 600 v or less. Provides application and descriptive information, ratings, dimensions, operating characteristics, and construction details. General Electric Co.

110 Industrial Batteries — Sixteen-pp Booklet GB-1788 is designed to help industrial battery buyers select the most economical and efficient battery for their operation. It outlines significance of battery design, and the contributions of research and development to lower operating costs, greater productivity. Selection, correct charging and handling, maintenance and other aspects of battery usage are outlined. Gould-National Batteries, Inc.

111 Pushbutton Stations — Standard and heavy-duty pushbutton stations are described in 8-pp Bulletin GEA-6544. It gives features, ordering information, dimension data, and applications, and includes photos showing extent of each line and illustrations showing features of heavy-duty types. General Electric Co.

112 Electrical Connections — Low cost, low resistance formed electrical connections are described in this 6-pp bulletin. Method of eliminating terminal lug difficulties is presented. Complete engineering information is given including operational methods for forming the connections and data on the new tool required. United States Research Corp.

113 Time Delay Relay — Bulletin SR3 describes a time delay relay, consisting of a pneumatic timing head, a solenoid assembly, a switch and terminals. Contact and terminal arrangements are diagrammed and complete specifications are included. AGA Div., Elastic Stop Nut Corp. of America.

114 Kva and Kvar Recorders — Eight-pp Catalog Section 35 provides a detailed explanation on how kva and kvar recorders can improve plant performance. Typical connection diagrams are presented. The Esterline-Angus Co., Inc.

115 Wire and Cable — Construction, voltage ratings and other specification data on Plasticord and Plasticote wire and cables for electronic wiring are featured in this 6-pp bulletin. Wire and cables for a variety of applications are pictured and described. Chester Cable Corp.

WATER, WASTE TREATMENT

116 Water Treatment Selection — Reprint 111, 8 pp, is an ASME conference paper on selecting water-treating processes for medium-pressure boilers. Covers determination of proper treating process in a paper mill in which, finally, hot lime zeolite was installed. Gives some economic studies of various methods for silica reduction and describes operating experiences since the hot lime zeolite process was installed. Cochrane Corp.

117 Evaluating Steam Purity — Technical Paper 135, 8 pp, entitled "Conductivity vs Sodium by Flame Spectrophotometer In Steam-Purity Studies," presents results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

118 Water, Waste Treatment — This 32-pp booklet deals with products and processes for water and waste treatment. Containing cross-references for detailed bulletins devoted to specific equipment in municipal, industrial, sewage and industrial water treatment fields, this booklet serves as a hand informational catalog. Fully illustrated, covers aerators; chemical feeders; proportioners; coagulation, precipitation and stabilization equipment; mixers and coagulators; clarifiers, filters and control equipment; ion exchangers, others. Infilco Inc.

119 On Biological Fouling — Eight-pp Technical Paper 134, discusses biological fouling in recirculating cooling water systems. Covers common problems of slime and algae in this system and points out how deposits of biological origin can interfere with heat transfer. A discussion of control agents for overcoming this situation and selection of proper toxicant is included. Betz Laboratories, Inc.

INSTRUMENTS AND CONTROLS

120 Temperature Regulators — This bulletin describes company's Series UB packless balanced self-operating temperature regulators for regulating steam to control temperature of ovens, drying or processing kilns, tubes, water tanks, other industrial heating applications. Includes photos, engineering drawings, construction features, principles of operation, specifications. Cash Standard Stacon Corp.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 127 and 128.

121 Balanced Valve Regulator — Bulletin 1082, Rev. 2, 12 pp, describes company's 014 low-pressure balanced valve regulators. Includes a detailed schematic drawing illustrating use of the 173 high-pressure regulator for pilot-loading of the 014. A similar drawing showing use of

the Type 39 power pilot regulator for the same purpose, with the help of a new adapter which facilitates mounting, is also included. Meter and Valve Div., Rockwell Mfg. Co.

122 Feedwater Control — Bulletin 1028 describes company's Type P regulator for remote control of boiler feedwater. The system modulates boiler-water feed by up to three influences — drum-water level, feedwater flow, and steam flow. Bulletin discusses primary elements and illustrates schematic hook-ups of the system for simple-level, Flowmatic and balanced-flow control. Also describes a "bumpless" auto-manual control station, and related equipment. Copes-Vulcan Div., Blaw-Knox Co.

123 Gas Regulation — Revised, 8-pp Bulletin 1024-6, on high pressure gas regulators, features a new regulator designed to withstand momentary overloads up to 1000 psi on outlet side. Other regulators are also presented, along with dimensional and capacity data, design features and application suggestions. Some typical hook-ups are illustrated. Meter and Valve Div., Rockwell Mfg. Co.

Reference Literature on Electromagnetic Controls

124 Automatic Transfer Switches — Catalog 57-81, 58 pp, provides complete information on automatic transfer switches (mechanically or magnetically held), designed to automatically transfer a load from a normal (or preferred) source to an emergency source upon failure or reduction in voltage of normal source. Operation and applications details are covered and specifications, dimensions and weights, dimensional diagrams, wiring diagrams and other illustrative material included. Automatic Switch Co.

125 Remote Control Switches — Engineering data and descriptive detail on company's line of remote control switches are featured in 80-pp Catalog 57-82. Fully illustrated with photos, drawings and diagrams, the catalog describes operation and construction features, methods of control, and presents complete technical information on the remote control switches, which are used for convenient and accessible control of power and lighting circuits from any number of control stations. Automatic Switch Co.

126 Electric Plant Controls — Catalog 57-86, 16 pp, describes electric plant controls, including complete systems, paralleling, changeover and alternating panels, load demand controls, battery chargers and adapter units. Operation and application details are covered, and list price and dimension tables included. Automatic Switch Co.

PUMPS, PUMPING

127 For Pumping Corrosives — To help select correct corrosion-resistant pumps for any application to 350 gpm, 20-pp Ace Pump Manual CE-55 presents comparative data for four types of pumps. Molded hard rubber centrifugal pumps, rubber-lines centrifugal pumps, Neoprene impeller pumps and gear pumps are included. Manual lists nearly 200 common chemicals and tells which pumps are suitable at room, warm or hot temperatures. Capacity charts and specification data included. American Hard Rubber Co.

128 Metering Barrel Pump — Bulletin 1256 describes advantages of company's controlled volume barrel pump in combined pumping and metering of toxic or corrosive chemicals from barrels or drums. Specifications and dimensions are included. Milton Roy Co.

VALVES, TRAPS, PIPING AND ACCESSORIES

129 Control Valves — Specifications S 810-11 and S 810-12 gives details of construction on single-seated and double-seated diaphragm control valves. Included are sizes, materials, plug characteristic curves, dimensions and a cross-section drawing of each type. Industrial Div., Minneapolis-Honeywell Regulator Co.

130 Check Valves — Basic check units, which can be combined with any standard pipe fitting to form a complete check valve, are described in 8-pp Form 300. Illustrations show unit used with a reducing bushing, 45-deg el, side outlet, drain elbow, bend and standard elbow as well as with tanks and pressure vessels. Pressure and temperature ratings are listed, as well as sizes and weights and other data. Durabla Mfg Co., Inc.

131 Flexible Valves — Flexible, pinch-type, hose-bodied valves for abrasives, corrosives, slurries and foods, are detailed in 50-pp Catalog FL-1116. Both standard and new SuperSeal metal-enclosed designs are included. Advantages of the valves are stressed, and a broad range of fluids handled are listed, according to industry classification. Specifications, materials of construction and dimensions are given for both manually-operated and motor-operated models. A technical data section provides capacity, flow and correction factors; installation and maintenance instructions; corrosion guide. Farris Flexible Valve Corp.

132 PVC Valves, Fittings — This 16-pp bulletin describes polyvinyl chloride valves and fittings offering resistance to most salts, alkalis and acids. Bulletin provides application tables on performance of normal impact PVC valves and fittings for handling 315 fluids that attack other materials. Cutaway drawing and text detail design features for long-time control of corrosives. Tables show physical properties, recommended working pressures and effect of temperature on working pressure. Fittings for threaded and welded pipe are shown, and installation and assembly guides for piping systems included. Walworth Co.

133 Pump Valves — This 8-pp bulletin describes pump valves redesigned to incorporate a new taper-lock stud, self-locking nut and drop-on guard. Features are illustrated. Tables give pressure-temperature ratings, materials of construction, dimensions. Durabla Mfg. Co.

134 Impulse Steam Traps — Bulletin T-1746 announces the Yarway Series 40 impulse steam trap designed especially to handle heavy condensate loads. Describes the operation of the trap, gives sizes and capacities, lists typical applications, and shows dimensions, weights and prices. Yarnall-Waring Co.

135 Steam Trap Guide — Bulletin 154 is a condensed buying guide on steam traps. Contains specifications, capacities, sizes, pressures, weights and list prices for all principal types of Super-Silvertop traps. Outstanding features are reviewed. Bulletin also gives data on self-cleaning strainers and steel series steam traps. The V. D. Anderson Co.

136 Improved Steam Trap — The Monovalve float thermostatic steam trap, developed for draining steam-hot condensate, is introduced in 8-pp Catalog 600. Explains how three functions are combined in one valve. Features of trap are stressed, and drawings show its action in air venting, steam trapping, draining low and high capacity, serving as check valve. Physical and capacity data on this bimetallic trap are provided, and simplified piping hook-ups shown. Valan Valve Corp.

137 Titanium Pipe, Tubing — Bulletin TDC-185, a 12-pp technical data folder, discusses seamless titanium metal pipe and tubing. Presents in detail the size range and tolerances as well as a description of the mechanical, physical and working properties of titanium in tubular form. Tubular Products Div., The Babcock & Wilcox Co.

138 Stainless Tubing, Pipe — This bulletin on 17-7PH stainless tubing and pipe gives a description of the alloy in tubular forms, along with analysis, recommended uses, typical mechanical properties, corrosion resistance, workability and hardening characteristics. Also covers physical and non-destructive tests given the tubing and pipe in manufacture. Charts show sizes available. Alloy Tube Div., The Carpenter Steel Co.

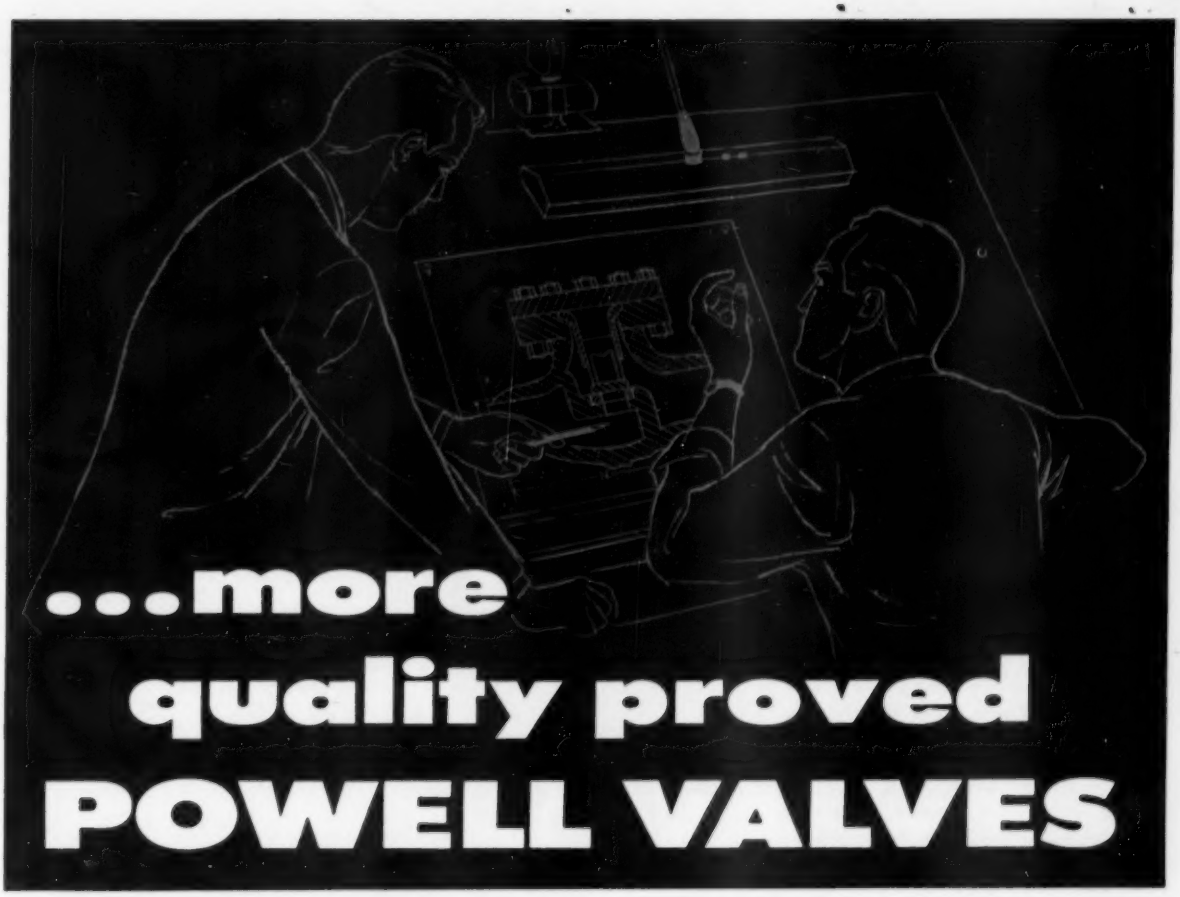
139 Piping Fittings — Speedline corrosion-resistant fittings for stainless steel piping are described and illustrated in this 24-pp catalog. Connectors, flanges, reducers, expanders, tee's, bends and unions are among types covered. Special advantages, including the "tangential feature" for easier installation, are discussed. Dimensional and torque data are provided, as are test results. Also described is Speedline heat exchanger. Booklet includes general information on soldering, welding, and silver brazing of stainless steel. Horace T. Potts Co.

140 Data on Purifiers — This 8-pp 1957 catalog (Bulletin 801) covers uses and advantages of company's purifiers which prevent mist carryover from process vessels; remove compressor oil, condensate from steam, air and gas vapor; separate solids and liquids from natural gas; and eliminate condensate and oil from steam systems. Information is included on improved types of internal purifiers, line type purifiers, receiver type scrubbers. A selection chart shows recommended sizes of line type units at various steam flows on different pressures. The V. D. Anderson Co.

141 Expansion Joints — Bulletin EJ-1915, 8 pp, describes company's Type W Gun-Pakt expansion joints, featuring an improved one-piece design of body and gland which eliminates customary bolted joint between body and gland. Gives data on how to figure expansion of pipe lines and suggestions for installation of expansion joints. Yarnall-Waring Co.

HEATING

142 On Gas Unit Heating — Pocket-size Bulletin SA-571, 20 pp, presents data on application of gas unit heating. An aid



...more quality proved POWELL VALVES

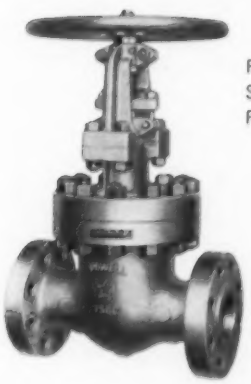


FIG. 1303 SS—1500-Pound Stainless Steel Gate Valve for handling Boiler Feed Water Treating Compound.

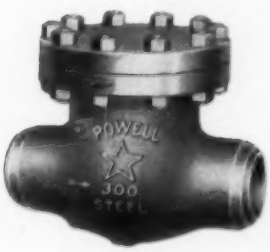


FIG. 3061 WE—300-Pound Steel Swing Check Valve.

FIG. 1314 A—1500-Pound Integral Bonnet Steel "Y" Valve.

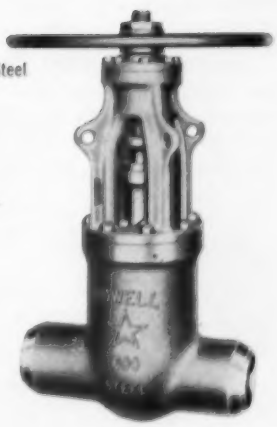


FIG. 16003 WE—600-Pound Steel Pressure Seal Gate Valve.

Designed for long life, designed for dependable service

Consult your Powell Valve distributor for all the facts about quality proved bronze, iron, steel and corrosion-resistant valves. No matter what the flow control problem, a Powell Valve can solve it . . . *better.*

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

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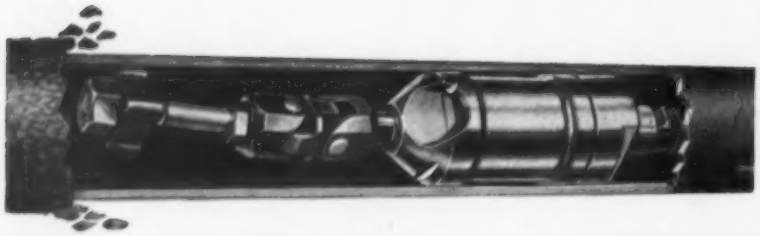


ROTOJET®

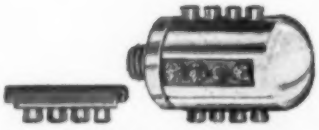
Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸ INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.

Model S525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model S505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

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in determining situations in which this system of heating can be applied, it gives basic information on selection and installation of proper equipment. Not a technical manual, it serves as an outline to proper use of gas unit heaters. Tells when and where to use these heaters, how they cut heating costs, and things to remember about heater and thermostat locations and venting. Reznor Mfg. Co.

143 Water Heater Data — Complete information on company's copper-lined storage water heaters is presented in Data File, 16. Designed for use as a file folder, it contains all data needed to specify and select these heaters for industrial or other installation. Bulletins contained within the file cover provide diagram of construction details and recommended minimum specifications; a tabular section of dimensions, heating capacities and engineering data; installation tips and piping arrangements; and illustrated case histories of typical installations. The Patterson-Kelley Co.

144 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and non-deaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

145 Finned Tube Radiation — Catalog FT-55, 20 pp, describes finned-tube radiation and enclosures for commercial and industrial uses. It covers 15 basic heating elements and company's "F" sloping top, "E" flat top, Sil-Vector and Sil-N-Wall enclosures. Ratings and dimensions, as well as illustrative detail are included. The Rittling Corp.

MECHANICAL POWER TRANSMISSION

146 On Worm Gear Drives — Sixteen-pp Bulletin 145 provides "fingertip facts" on standard speed reducers, worm gear sets and special units. Horizontal right-angle reducers, vertical reduction units, multiple reduction units, fan cooled types are among those covered in detail, and some specialized reducers for custom-design requirements are illustrated. Generously illustrated, book covers special features of various drives, their applications. The Cleveland Worm and Gear Co.

147 Data on Drives — Data Book 10 is a 112-pp engineering guide on selection and design of Poly-V belt drives. It contains charts, tables and diagrams along with specifications for all drive sizes. Selection of proper belts and sheaves for drives of any speed or horsepower is made possible, without calculation, by standard drive tables. Book covers theory and practical application of the new R/M Poly-V drive, along with illustrated case histories. Comprehensive data on V-belt drives is included — drive tables, ratings, installation instructions and trouble shooting. While not a textbook, this manual should prove a useful tool to those concerned with industrial belt drives. It is available to qualified power engineers. Please state job title when requesting it. Manhattan Rubber Div., Raybestos-Manhattan, Inc.

148 For Longer Belt Life — Simple precautions to prolong the life of V-belts

new Misericordia Hospital will

SAVE THREE WAYS *

BY INSTALLING

FW PACKAGED STEAM GENERATORS

Lowering one of the 43,500 lb FW Packaged Steam Generators into the basement of the Misericordia Hospital.

SCHEDULED for completion early in 1958, the $8,000,000, 210-bed Misericordia Hospital, Bronx, N.Y., will be fully equipped with the finest and most modern facilities obtainable.

All steam requirements will be supplied by three fully-automatic Foster Wheeler Packaged Steam Generators, each rated 17,500 lb/hr at an operating pressure of 125 psi. Each two-pass steam generator contains 1857 sq ft of heating surface and generous furnace volume. Staggered tube arrangement permits a high heat transfer rate and low exit gas temperatures. These FW Packaged units also offer the following cost-saving advantages:

* **SAVE TIME** — because they were completely shop fabricated and delivered by truck direct to the building site, all ready to set in place and connect to power, fuel and steam lines.

* **SAVE SPACE** — because of exceptionally low ratio of unit size to quantity of steam produced. Measuring only 12'1½" high, 10'11½" wide and 16½' long, these 17,500 lb/hr units are installed on small, low-cost foundations.

* **SAVE MAINTENANCE** — because they are specially designed for easy servicing and inspection. Consisting almost entirely of water heating and steam producing pressure parts, there is a minimum of refractory and tile maintenance.

FW Packaged Steam Generators are available in capacities from 10,000 to 60,000 lb/hr and pressures to 1300 psi. For complete information, send for Bulletin No. PG-55-3. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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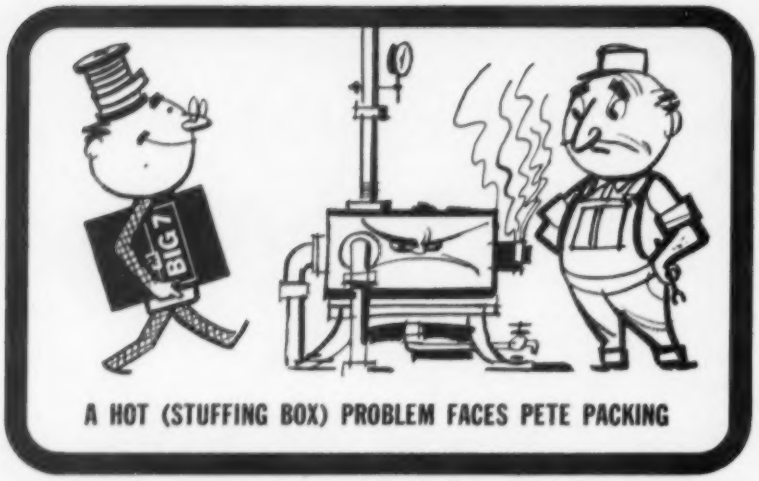
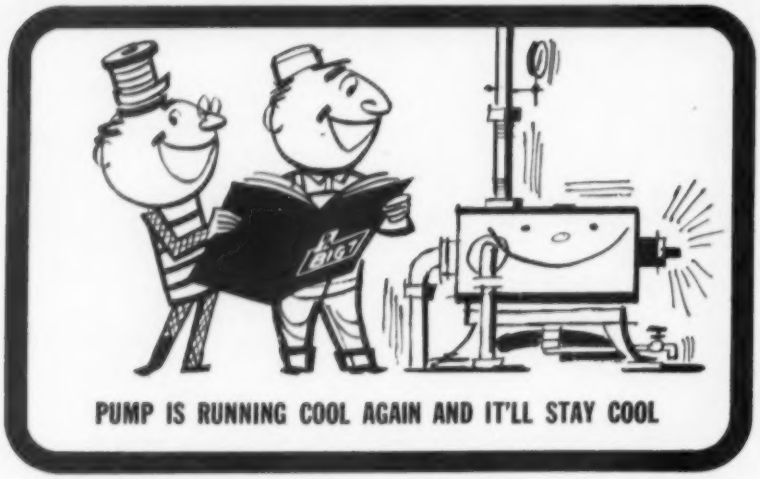


A HOT (STUFFING BOX) PROBLEM FACES PETE PACKING



PUMP IS RUNNING COOL AGAIN AND IT'LL STAY COOL

Lubricants that are mere surface coatings can't stop heat build-up. But in R/M's Big 7 Packings, the lubricants are ground in during manufacture. Heat cannot dissipate them, nor pressure force them out. They're there to stay! So much so that even after the packing starts to wear, the bearing surface remains lubricated. And there's no shaft scoring, either!

This is but one of many superior features of the Big 7. By standardizing on this basic line (chances are you'll actually need only 3 or 4 for all your packing problems), you save on inventory, need lower initial cash investment, and make ordering easy as pie.

Ask the R/M distributor to lend you a helping hand. He'll be glad to. And when it comes to packing problems, you'll find him an expert.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M packings for maintenance purposes are sold only through authorized R/M distributors

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PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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increase drive efficiency and thereby assure full continuous production are contained in 12-pp Bulletin 20X6234C. Describes various types of belts and tells how to select and match them. Correct installation of belts, common causes of belt destruction are also covered. Allis-Chalmers Mfg. Co.

149 V-Belt Economy — Disadvantages of makeshift and other ill-advised means of coping with stretched or broken V-belts are discussed briefly in this folder. Answers questions on V-belt maintenance, inventory, wear vibration. It features Veelos adjustable link V-belting for which manufacturer claims less vibration and faster belt changing. The Manheim Mfg. & Belting Co.

150 Magnetic Clutch — Bulletin M-101, 6 pp, details advantages of company's magnetic clutches for industrial applications. Provides dimensional drawings and specifications on Model SC magnetic clutch, Model SB magnetic brake, and Model SBR magnetic brake. Fawick Airflex Div., Fawick Corp.

151 Industrial Gearing — Twelve-pp Booklet B-7012 outlines design facilities and manufacturing capacity of company's gearing division in producing custom-made gearing. Specialized machinery and heat-treating equipment are shown along with text covering the BP taper hardening process. A complete machinery listing is included. Westinghouse Electric Corp.

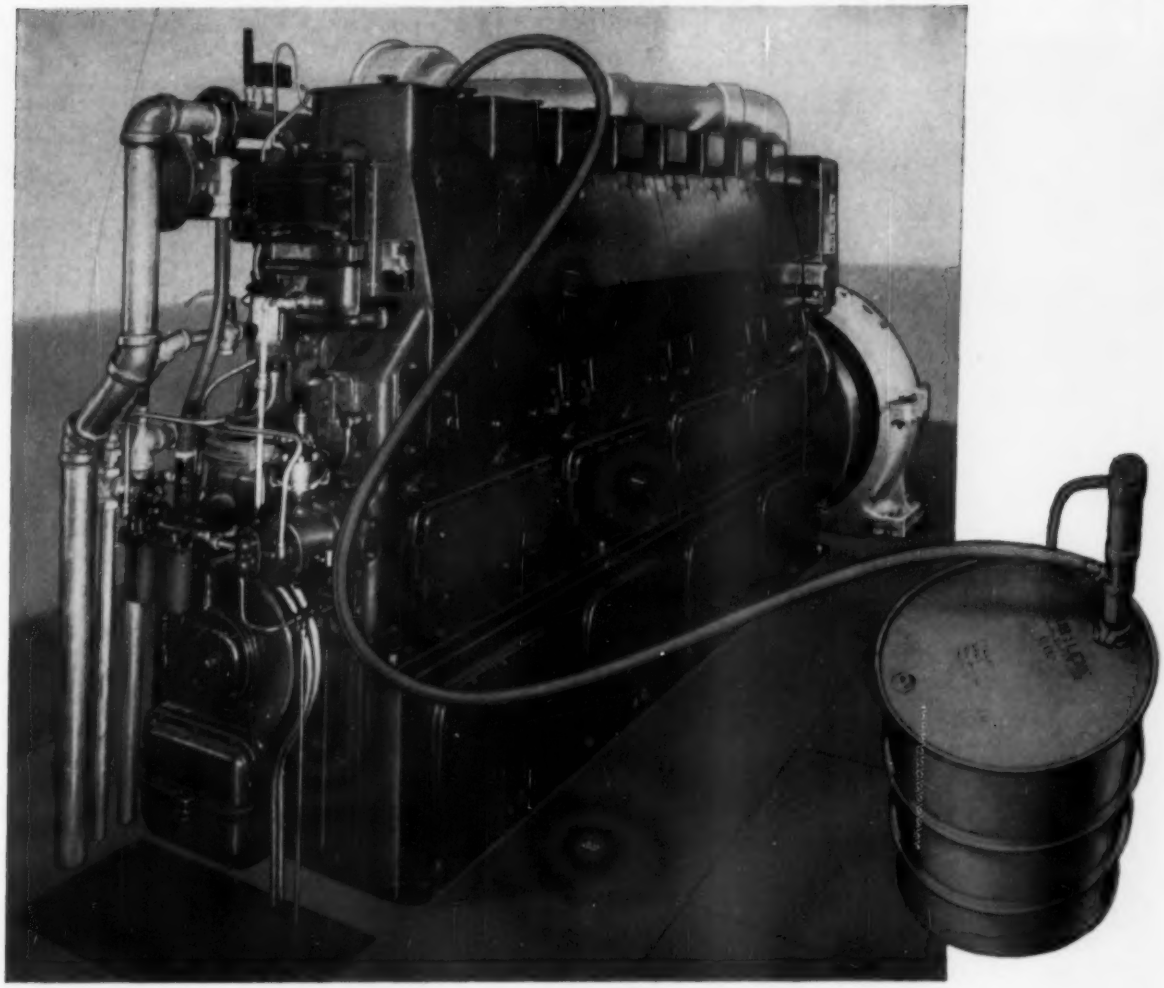
152 Split Ballbearings — The advantages of company's fracture process of manufacturing split ballbearings are detailed in 26-pp Catalog 57. The fractured race technique is described and illustrated, and typical applications are listed. Complete specification data on various types of split ballbearings in the line are also included, as well as photos, drawings and diagrams illustrating details of design and construction. Split Ballbearing Corp.

AIR CONDITIONING, VENTILATING, DUST CONTROL

153 Multi-Zone Conditioners — Eight multi-zone conditioners in this company's Flow-Temp line are described in 12-pp Catalog 383. These units are specifically designed for buildings in which heating and cooling are required simultaneously; they range in capacity from 1370 to 21,000 cfm of air. Engineering specifications, capacities, selection examples, performance tables, dimensions and a description of accessories are included. Acme Industries, Inc.

154 Guide to Diffusers — Eighty-pp Selection Manual 60 presents air diffusers for air conditioning, heating and ventilating systems. Contains numerous diagrams, tables and photos to aid in selection of diffusers and accessories for all-air high velocity and conventional air conditioning systems and units. All types of round, square and straight line diffusers are pictured. Included in manual are air distribution definitions, sound level characteristics, static pressure factors and typical installations. Anemostat Corp. of America.

155 Precipitator Automation — This 8-pp bulletin describes a system which brings complete automation to power inputs of electrostatic precipitators, eliminating manual adjustments and increasing round-the-clock dust and fume collection efficiencies. Defines "ideal electrical power" and demonstrates, by means of



Stops Thin-Out!

You can protect your Diesel against wear due to excessive thin-out of the lubricating oil at higher operating temperatures. Switch to Sinclair RUBILENE®, *the high viscosity index oil* proved by over 35 years in a wide variety of Diesel applications. You'll find RUBILENE holds its high film strength and reduces oil consumption . . . gives you better protection of cylinders, pistons, rings and other vital moving parts operating continuously for long periods. Your Diesel logs more full-power hours!

Switch now to RUBILENE. Regardless of the make of your Diesel, there's a member of Sinclair's famous RUBILENE or RUBILENE HD family that meets your needs exactly! Call your local Sinclair Representative or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation!*

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comparative charts, how optimum precipitator power level can be more closely approached by automation than by manual control. Research-Cottrell, Inc.

156 Centrifugal Collectors — Two design types of centrifugal collectors are described in this 6-pp bulletin, which explains industrial applications for each in efficient air cleaning and dust collection through centrifugal force. Complete specifications are included, as well as dimensional drawings and information on collector selection by determining particle size, etc. The Kirk & Blum Mfg. Co.

OTHER EQUIPMENT

157 Lube Fittings — Covering a complete line of lubrication fittings, this 32-pp catalog serves as a handy guide to ready selection of the right fitting for every requirement. Included among listings are fittings developed for many special purposes, such as relief fittings, measuring fittings, drive fittings. Individual dimensions ready for transfer to blueprints are provided for all fittings. Catalog also presents accessories such as bushings, elbow bodies, plugs, couplers etc. along with specifications and application data. Alemite Div., Stewart-Warner Corp.

158 Discharging Centrifuge — Bulletin NC-104 describes company's Model AC-VO Nozzle-Matic centrifuge. Used to separate, clarify, classify, or concentrate liquid or liquid-solid moisture high in solid content, this centrifuge continuously discharges all phases including solids. Bulletin describes applications for machine and gives flow charts showing types of nozzle bowls available. The De-Laval Separator Co.

159 On Teflon Packings — Service and technical details on chemically inert mechanical packings fabricated from Teflon are provided in 8-pp Bulletin P-325 on Chemlon packings. Presents braided types, rings, molded packings, sup and cone rings and combination sets. Bulletin gives recommendations as to applications and temperatures. Includes data on pressures, dimensions and mechanical requirements. Crane Packing Co.

160 On Pipe Welding — Developments in welding of steam-power piping are described in 8-pp Booklet F-1055. Dealing with the welding of chrome-moly alloy-steel piping, this article reviews work done to improve welded power piping in recent years. Photos and tabular data augment text. Linde Air Products Co., Div., Union Carbide and Carbon Corp.

161 Grating and Treads — Bulletin 2527 is a 26-pp, illustrated bulletin on grating and treads for a variety of applications. Presents descriptions of electroforged, riveted, rectangular, diagonal, U-type and T interlocked grating and treads. Tables of safe loads and information on specifying are also included, as well as photos of typical applications. Blaw-Knox Co.

162 For Pipe Marking — How to select self-adhesive pipe marking materials is told in 8-pp catalog 2157. Over 500 self-adhesive vinyl plastic pipe markers carried in stock and conforming to accepted standards are listed. Cut-out numbers and letters and safety slogans are shown along with other self-adhesive products used in plant maintenance and safety programs. Printed Cellophane Tape Co.

"Lock out" algae scum from water systems

HTH Granular, the *dry* chlorine product, slams the door on algae growths that cause heat transfer loss, produce offensive odors and clog up recirculated-water systems.

HTH Granular contains 70% available chlorine. When added *directly* to water, it dissolves immediately to release a fresh hypochlorite solution that provides sure, fast algae kills in condensers, spray towers, cooling ponds, reservoirs and air-conditioning equipment.

One ounce of HTH per 1000 gallons of water is usually enough to control algae growths. Because algae growths form slowly, in most cases only a periodic "shot" treatment with HTH is necessary. This varies, of course, with the nature and condition of the specific water supply.

Safe, easy-to-store and easy-to-use, HTH Granular is packed in 100-lb. drums and in cases of nine 5-lb. cans. Your supplier can answer all your questions about HTH, or if you prefer, just write.

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OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

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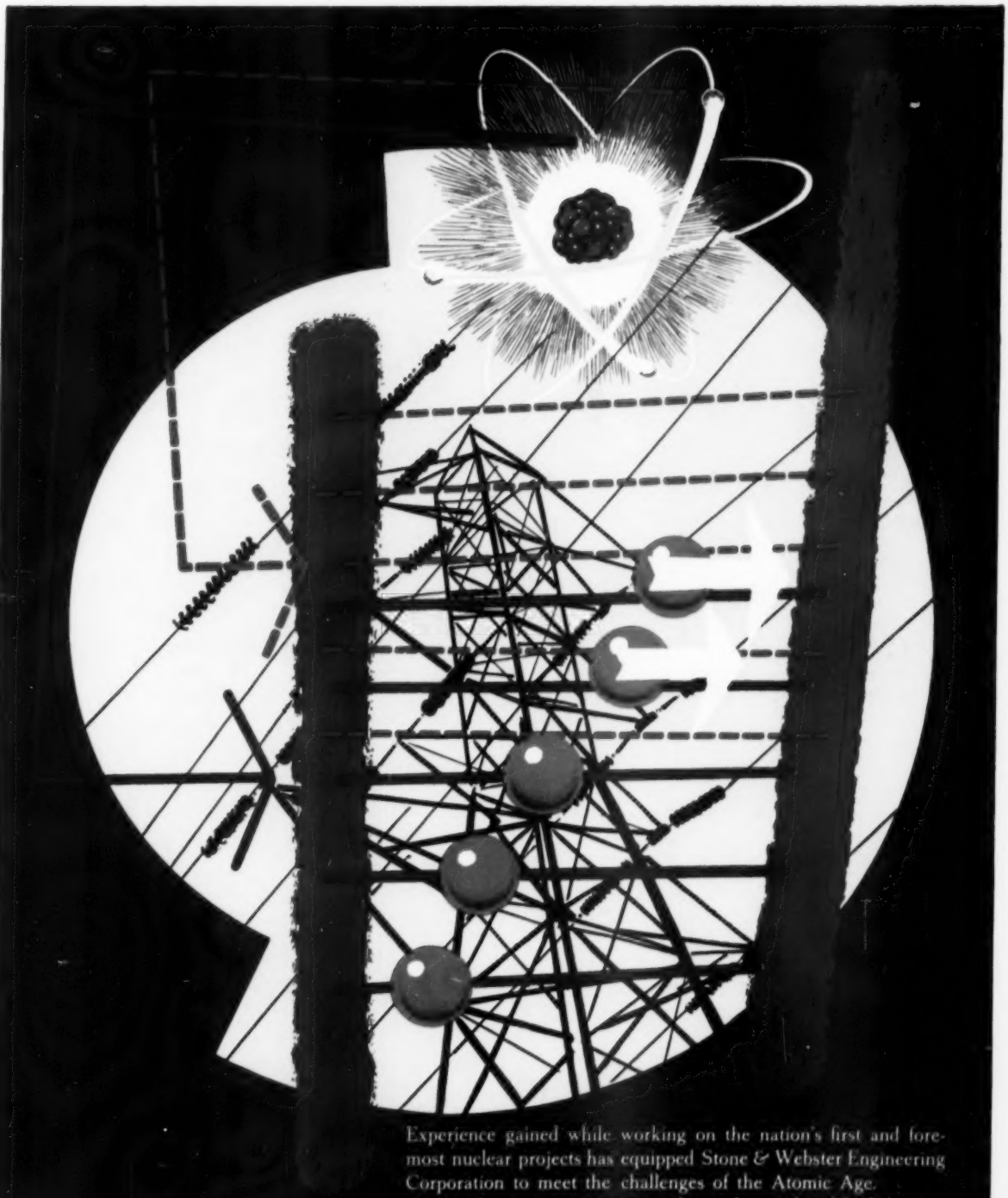


Experience gained while working on the nation's first and foremost nuclear projects has equipped Stone & Webster Engineering Corporation to meet the challenges of the Atomic Age.

Among the newest projects now being designed and built by Stone & Webster, in partnership with Westinghouse Electric Corporation, is the 134,000 kw Yankee Atomic Power Project at Rowe, Massachusetts — a plant which will bring to New England its first source of electric power from atomic energy.

Write or call us for information as to how our experience can be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

New York • Boston • Chicago • Pittsburgh • Houston • San Francisco • Los Angeles • Seattle • Toronto

*Wholly owned subsidiary of South Carolina Electric & Gas Co.

REPUBLIC *Automatic* COMBUSTION CONTROLS *Anticipate* FUEL-AIR-WATER REQUIREMENTS!

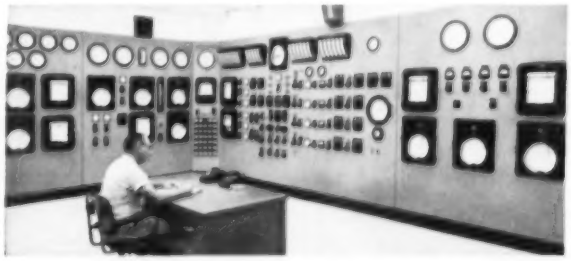
● Adjusts fuel, air and water as steam flow changes ● Makes follow-up adjustment of header pressure and water level if needed ● Prevents (rather than corrects) most pressure, level and temperature fluctuations before they happen!

Planned expansion of power in the Southeastern United States is typified by the addition of Unit #3 to South Carolina Generating Co.'s Urquhart Station. Rated capacity of the steam generator is 700,000 lb/hr at 1825 psi, superheated to 1010 F and reheated to 1010 F. Designed by Gilbert Associates, Urquhart #3 is modern in performance as well as appearance.

REPUBLIC's "Electronic Master" combustion control and triple-element feedwater control permit firing of pulverized coal, natural gas, or both at once without fluctuation of header pressure or water level. This system starts adjusting fuel, air and water as soon as steam flow changes perceptibly, not waiting for either drum level or header pressure to change.

If either of these factors change despite the preliminary adjustment, the change will be very small and will be offset immediately by a follow-up control that modulates the existing control signal. Since the flow of flue gas is held in such close proportion to the steam flow, temperature at the superheater outlet is held very close to a constant 1010 F despite load swings.

This advanced control system is a logical partner to the advanced thinking apparent throughout Urquhart #3. The quick action of electronic control added to the traditional reliability and power of pneumatic actuation produces a stable, accurate, dependable automatic system. And any one or all of the automatic control functions can be cut out at will to permit substitution of remote manual control at any time. Manual controls include indicators for electronic loadings of the regulators and positioners as well as position and rate of response indicators.



Control room of Urquhart Station's modern Unit #3.

NEED HELP on "Early Stage" Planning?

Remember that Republic, too, is planning ahead. To get the latest information on developments that will effect control in your future power or processing plant, contact the REPUBLIC Engineering Department as soon as such help would be beneficial.

REPUBLIC FLOW METERS COMPANY

A Subsidiary of Rockwell Manufacturing Company

2240 Diversey Parkway, Chicago 47, Illinois

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Tough valve buyers appreciate this kind of... Toughness

*HAYNES STELLITE

Here's why:—They know that to foil those troublesome valve "termites"—erosion, corrosion, and galling—requires built-in toughness which only seats faced with hard facing alloys AND hardened wedges can provide. Yes, it takes BOTH to do a real job and GP Valves provide both at no extra cost!

Vogt GP Valves feature the toughest and, since they are precision finished, the smoothest seating surfaces obtainable anywhere. That's why they are setting new standards of performance—longer, drop-tight service with minimum, low cost maintenance—in petroleum refineries, chemical plants, power plants and other industries. Available in a complete range of sizes from ¼" to 2" and rated 800 pounds at 850° F. and 2000 pounds at 100° F.

Advt. No. 5 in a series describing the features of Vogt GP Valves.

Write For Your FREE COPY of Supplement No. 1 to Catalog F-9. Dept. 24A-FPE

HENRY VOGT MACHINE CO.
P. O. Box 1918—Louisville 1, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati.

Vogt GENERAL PURPOSE **GP** Vogt FOR BETTER VALVES

DROP FORGED STEEL

VALVES

HAYNES STELLITE—Trade-mark of Union Carbide and Carbon Corporation

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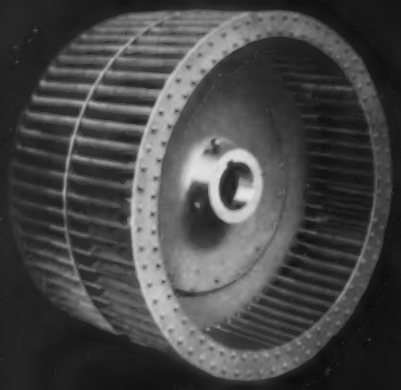
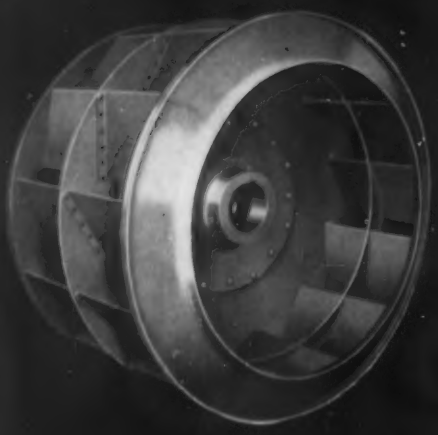
American Blower Fan Wheels



SIROCCO WHEELS

for forced and induced draft duty

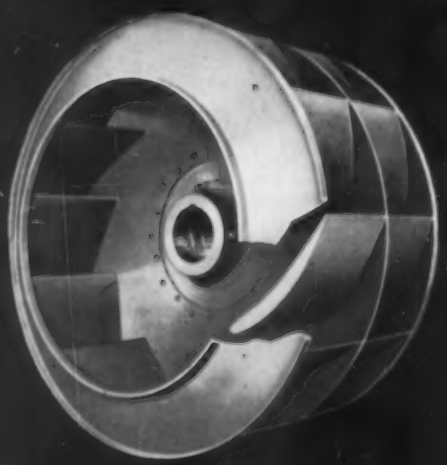
- For balanced draft or pressurized furnace
- Low tip speed
- Die-formed, forwardly inclined blades and heavy streamline inlets
- Used in power plants the world over



AHS WHEELS

for forced and induced draft duty

- Backwardly inclined, nonoverloading horsepower characteristic
- For given duty operates at higher R.P.M.
- Single thickness flat or curved blade
- Heavy rolled streamline inlets

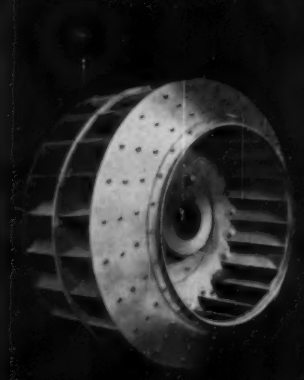


AIRFOIL BLADE WHEELS

primarily for forced draft duty

- Blades are of airfoil cross section, die formed and reinforced as required
- High mechanical and static efficiency
- Nonoverloading power characteristic
- Available with vanes and/or boxes

Meet Peak Efficiency Standards



Radial tip blade wheel

RADIAL BLADE WHEELS

for forced, induced and gas recirculating duties

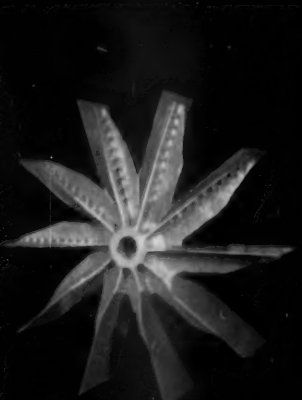
- Pressure characteristic favorable to gas recirculating application where unusual system pressures prevail
- Designed for severe temperature and pressure duty
- Available with straight radial or radial tip blades

Straight radial blade wheel

Rim type wheel for primary air fans

SINGLE INLET RADIAL BLADE WHEELS FOR PRIMARY AIR, VENT, AND OVER FIRE DUTY

- Designed for high temperature, high pressure applications
- Radial or backwardly inclined blades, single inlet
- Over 1200 primary air fans in operation



Rimless wheel for vent and over fire fans

IF YOUR plans include mechanical-draft equipment—for new installations or as replacements—consult your American Blower sales engineer. He can give you helpful information on job-fitted American Blower equipment to meet your power-plant requirements. Call our nearest branch office or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ont.

AMERICAN BLOWER

Division of AMERICAN-Standard

For more data circle 525 on Post Card

Which packing
for longer life in reciprocating service?

To 500F it's J-M Interlocked

because it cannot ravel or come apart

Made by an exclusive J-M process, Interlocked packing is braided from tough long-fibre asbestos yarns strongly interlocked in a solid integral structure. There are no jackets to wear through . . . no plaits to loosen. That's why it retains its strength and efficiency far longer than other types.

Interlocked also seals better. It is flexible and resilient, braided square for better contact and requires less gland pressure. Style 255 is effective against steam, hot or cold water, oil, weak acids and caustics. Furnished lubricated and graphited in ring and coil forms in sizes from ¼" and up.

To 750F it's J-M Superheat

because it does not harden under high heat

Designed specifically for superheated steam between 500F and 750F, Johns-Manville's Superheat packing is made of highest quality pure asbestos cloth which retains its resiliency even after long exposure to high temperatures. Woven tight, spiral wrapped and then pressed square, this cloth forms a firm resilient structure of superior strength and wearability.

Style 167 Superheat is bonded with a special heat resistant compound. No excess is present to carbonize in use. Density is carefully controlled for minimum gland pressure. Furnished graphited in ring and coil forms in sizes from ¼" and up.

Your local J-M distributor carries full stocks of Interlocked and Superheat and other packings. Call him today or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

JM

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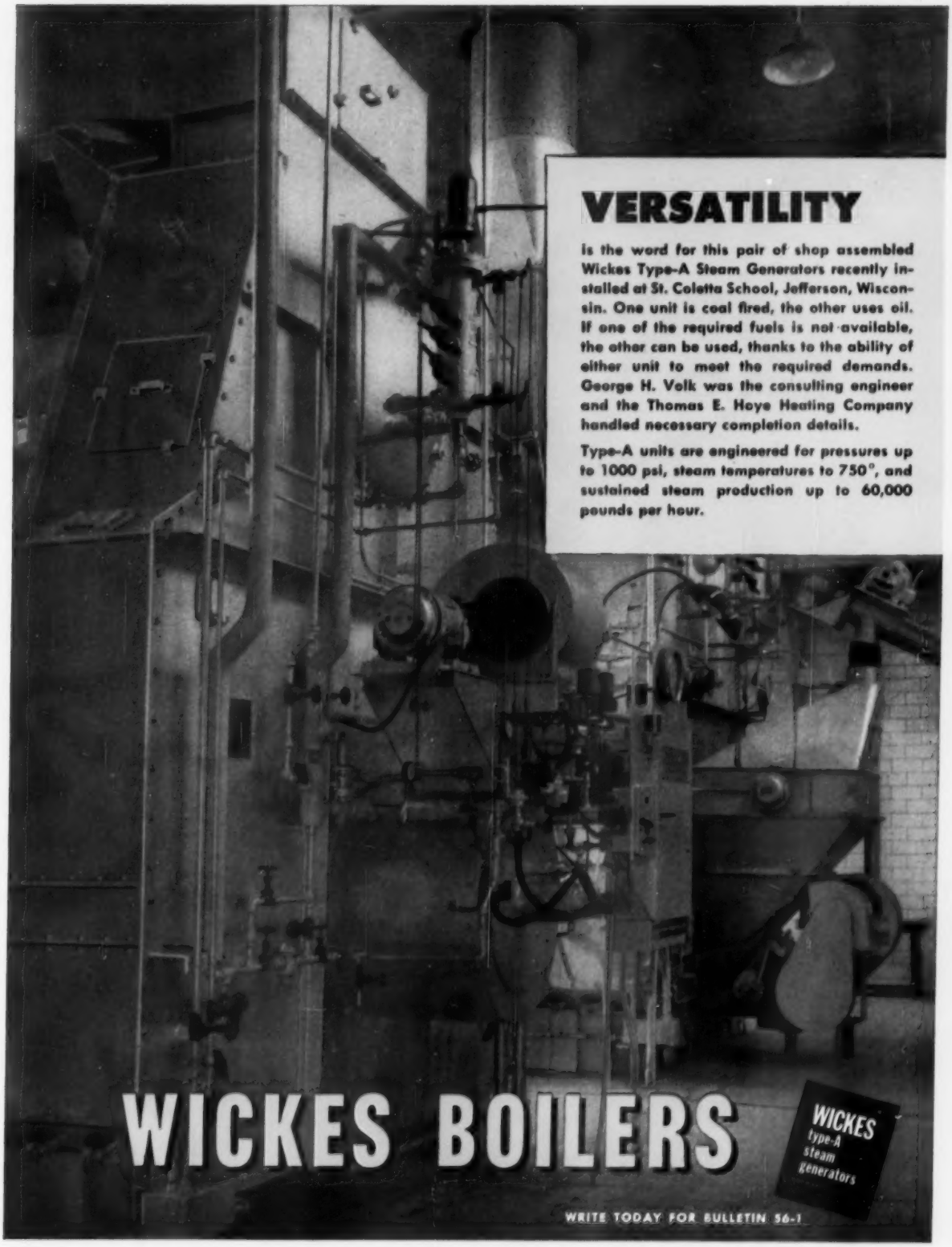

VERSATILITY
is the word for this pair of shop assembled Wickes Type-A Steam Generators recently installed at St. Coletta School, Jefferson, Wisconsin. One unit is coal fired, the other uses oil. If one of the required fuels is not available, the other can be used, thanks to the ability of either unit to meet the required demands. George H. Volk was the consulting engineer and the Thomas E. Hoye Heating Company handled necessary completion details.
Type-A units are engineered for pressures up to 1000 psi, steam temperatures to 750°, and sustained steam production up to 60,000 pounds per hour.
WICKES BOILERS
WICKES type-A steam generators
WRITE TODAY FOR BULLETIN 56-1

THE WICKES BOILER CO., DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

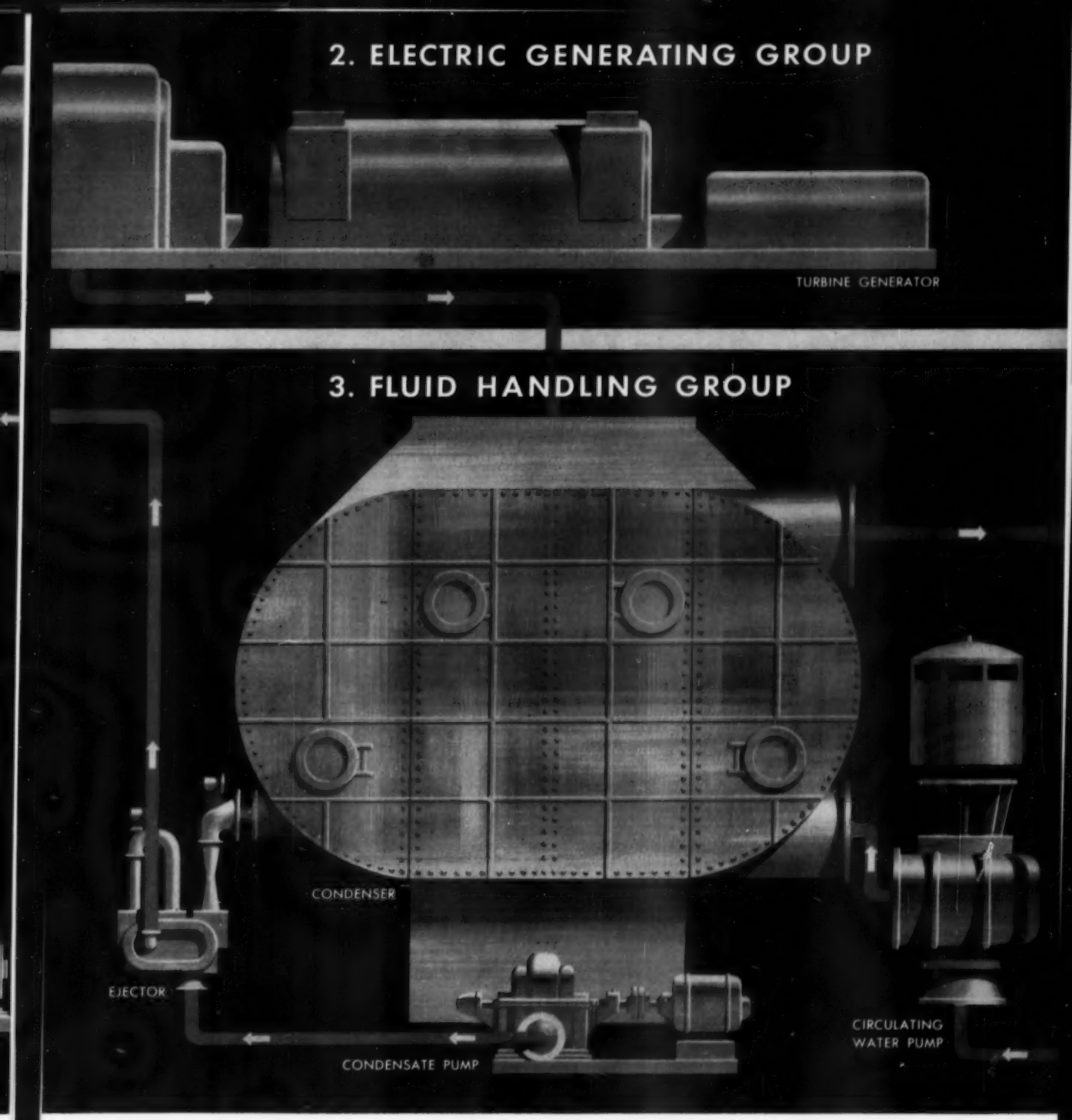
RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. • Saginaw Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C. 165

For more data circle 527 on Post Card

Look at all three

A new steam station design approach is bringing higher efficiencies, lower costs, and greater reliability. In this approach, only three basic functions are considered: (1) Steam Generating, (2) Electric Generating, (3) Fluid Handling. Station requirements are first analyzed in terms of the over-all job performed by each of these groups rather than by each individual piece of equipment.

Many of the benefits of this approach occur in the Fluid Handling Group. Here coordination and integration of the wide variety of equipment used can often effect substantial improvement in over-all operation. As steam temperatures and pressures go up, there are increased demands on the fluid handling function. Plant reliability often depends on the effect of one component of the fluid handling group on another during operational transients, either planned or of emergency nature. The solution is coordinated equipment



for power!

selection, engineering and design. And Worthington's "system" know-how and experience with modern complex plant cycles can help solve your fluid handling problems.

System-wise experience As the manufacturer of all major components of the Fluid Handling Group, Worthington has a reservoir of experience and knowledge that can be of benefit to you. To put this "system-wise" experience to work for you, get in touch with your nearest district office. Or write to section C-71, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON

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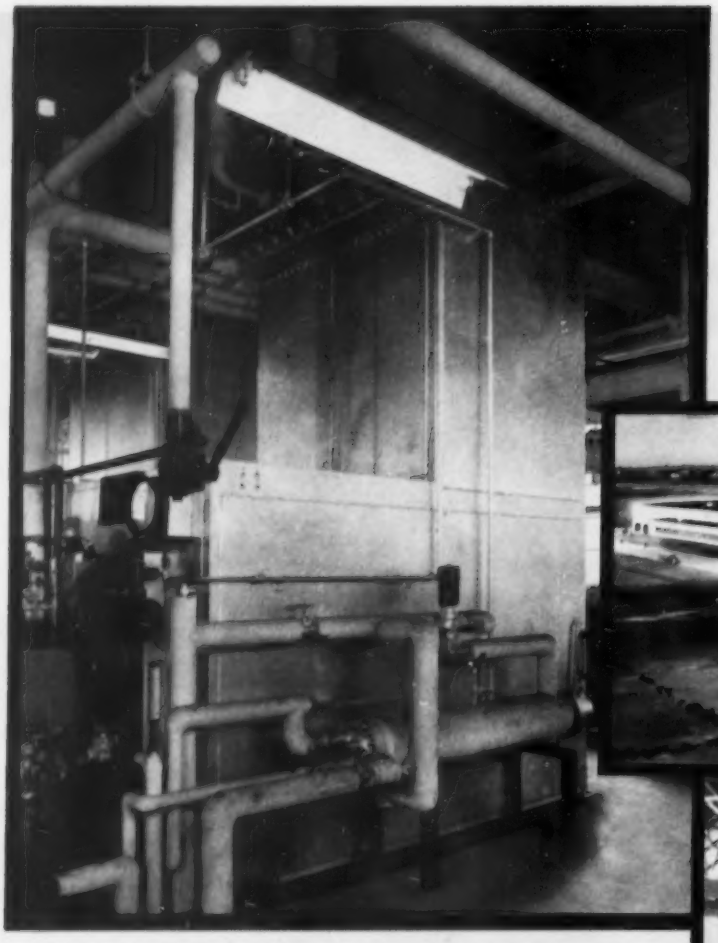
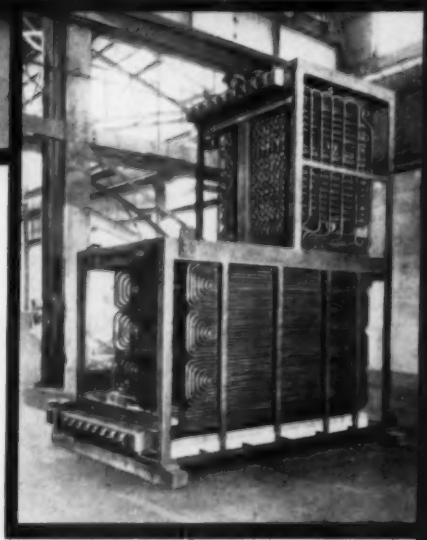
The Cross HIGH HEATING



C-E HT Boilers in service at the Cross Company. They are fired by oil or natural gas.



One of the two Cross Company boilers being assembled in the C-E shops.

THESE ARE THE GENERAL ADVANTAGES OF HIGH TEMPERATURE WATER:

1. Higher available heat — many times that of steam at the same pressure.
2. Closer control of temperature.
3. Lower heat loss . . . unused heat returns to the boiler . . . no condensate return lines.
4. No elaborate feedwater treatment . . . make-up requirements are exceptionally low.
5. Steam traps not required . . . trap problems and expense are eliminated.
6. No blowdown losses . . . no safety valve vent losses . . . no condensate losses.

THESE ARE THE SPECIFIC ADVANTAGES OF THE C-E "HT" WATER BOILER:

1. Complete control over circulation in both system and boiler.
2. No separate boiler pump is required, since low pressure loss is inherent.
3. Pressurized operation with oil or gas means no induced draft fan.
4. Single-pass design—no baffles—means cleaner boiler and lower draft loss.
5. Controlled, positive circulation permits more efficient arrangement of heating surfaces.
6. Any fuel—oil, gas, coal, or any combination of fuels.
7. Gastight, welded steel casing.
8. Fewer headers, all of which are easily accessible.

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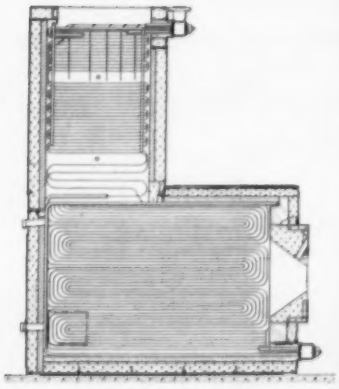
Company specifies–

TEMPERATURE WATER BY C-E FOR ECONOMY...LOW MAINTENANCE

Architect's drawing of the new Cross Company plant, Giffels and Vallet, Detroit, Consulting Engineers; Owen S. Lieberg, Associated Consultant.



Combustion HT Water Boilers are available in sizes from 10- to 300-million Btu per hour. Drawing shows one of the 12-million Btu/hr. Cross Company boilers.

The Cross Company, pioneer producer of automation machinery, has recently completed an ultra-modern plant in Fraser, Michigan – practically doubling its former production capacity. After a thorough study of heating requirements . . . and with a view toward further expansion . . . two C-E LaMont Controlled Circulation Hot Water Boilers were specified for the new plant. According to Mr. W. P. Reece, Plant Engineer, "the study indicated that this system would provide the lowest fuel and maintenance costs . . . Experience during this winter confirms the soundness of our decision."

The C-E LaMont Controlled Circulation Hot Water Boiler is available in sizes ranging from 10- to 300-million Btu per hour, with pressures up to 500 psi and temperatures to 470°F – or higher if required.

If you are in the market for a heating or process system, it will pay you, too, to investigate high temperature water. Individual needs vary, of course, and both hot water and steam boilers have their place. Our engineers will be pleased to discuss the subject with you or your consultants. Write for our catalog HCC-2.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

C-E

B-990

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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You get millions of feet of nuclear with *Carpenter* Stainless and High

● Carpenter's role in harnessing the atom, first for wartime use and later for national defense and peacetime uses, began during World War II. For nearly 15 years, Carpenter has cooperated with the AEC and prime contractors on many of the nation's top nuclear energy projects, supplying millions of feet of stainless and high alloy tubing and pipe for these installations.

Carpenter's leading role in the nuclear energy field is shown by the following applications: Carpenter supplied stainless tubing and pipe for Hanford Works' first production facility; the first finned tubing used by the AEC at Hanford Works; 100 miles of tubing supplied for the Dana Project; square-shaped tubing to Argonne National Laboratory for a boiling water reactor; and many more.

Significant Carpenter developments include the first successful use of welding to produce stainless and special alloy tubing and pipe . . . the origination of Schedule 5 pipe . . . super corrosion-resistant Stainless No. 20Cb . . . titanium tubing and pipe . . . long lengths of Alloys B and C . . . and stress corrosion-resistant 7Mo Stainless Tubing and Pipe.

More than 30 analyses of tubing and pipe can be and have been supplied for nuclear energy plants

Carpenter experience in producing millions of feet of tubing and pipe for nuclear energy requirements embraces these standard stainless analyses and specialty high alloys:

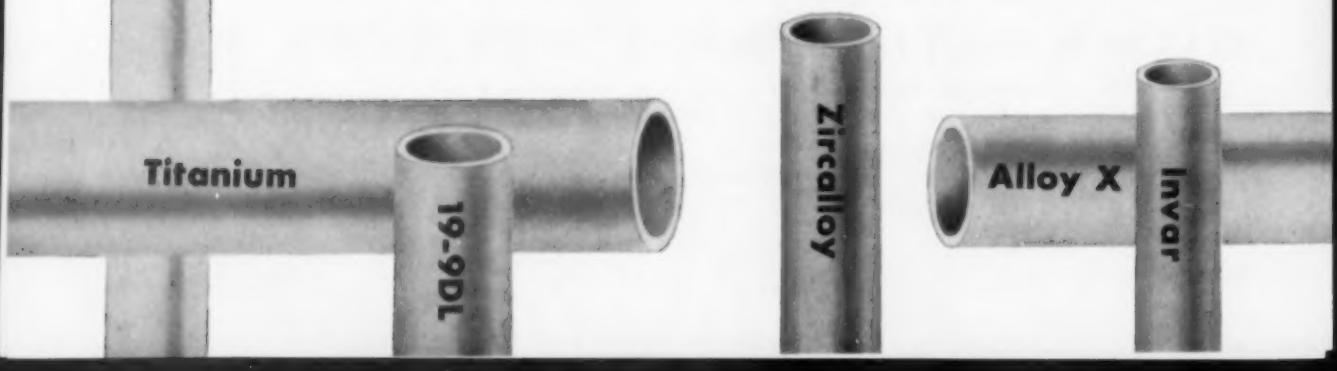
304	310	317L	348
304L	316	318	430
309	316L	321	442
309S	317	347	443
309S-Cb			

SUPER STAINLESS AND HIGH ALLOY GRADES

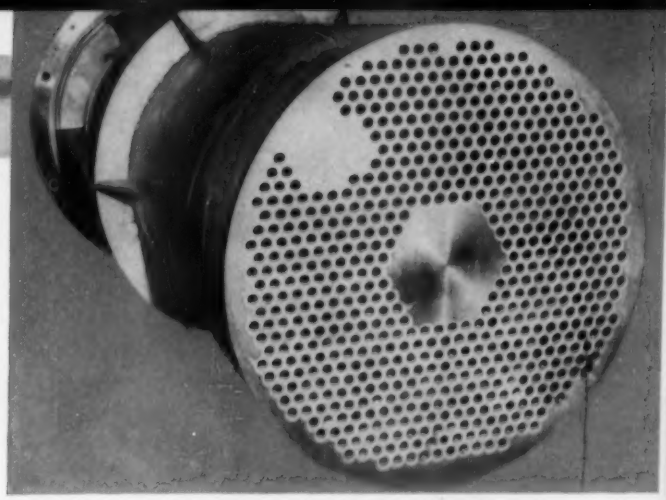
Zircalloy II	*Hastelloys:*	Invar "36"
Titanium C-55 or C-70	Alloy B	Invar "42"
Stainless No. 20Cb	Alloy C	HiMu "80"
Carpenter 7Mo (329)	Alloy X	430 Ti
19-9DL	Alloy F	N-155
19-9DX	25 (L-605)	

Wide range of sizes, gauges, lengths, forms and finishes for nuclear requirements

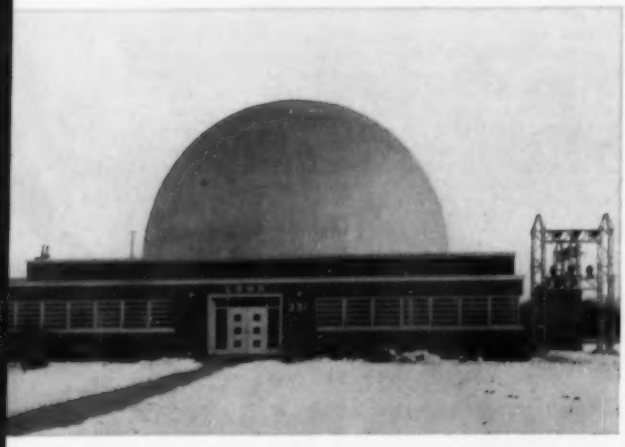
Tubing and pipe sizes available from Carpenter are as follows: *Tubing* from ¼" to 4½" O.D. with 35 BWG (.005") to 9 BWG (.154") walls. *Pipe* of Schedules 5 and 10 in sizes of ⅛" to 4" and Schedule 40 up to 2" IPS. Finishes range from as-welded to high polished. Regular lengths to 45 ft. with longer lengths when specified. Many shapes other than round can be supplied to order.



experience Alloy Tubing and Pipe



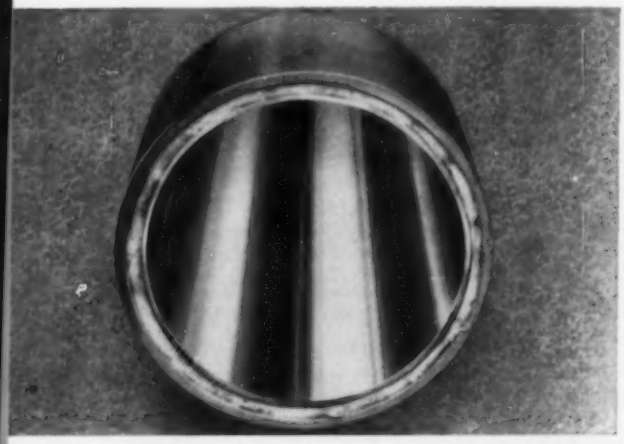
Carpenter Stainless Tubing is being used in many heat exchangers such as this one for nuclear energy applications. Carpenter quality and ability to meet extremely close dimensional tolerances make Carpenter Tubing ideal for use in heat exchangers.



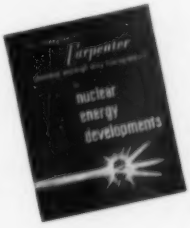
Carpenter has supplied square-shaped tubing for the boiling water reactor in the first nuclear power plant built specifically for electric power generation in the U.S., the 5000-kw experimental plant now in service at Argonne National Laboratory. Illustrated is a front view of the Experimental Boiling Water Reactor. Carpenter also supplied the tubing for the primary heat exchanger for a similar commercial-size plant under construction for a large Mid-West utility.

Photograph courtesy of General Dynamics Corporation

Reprocessing nuclear fuel on the Submarine Intermediate Reactor for the "Seawolf" calls for the use of super corrosion-resistant Carpenter Stainless No. 20Cb in tubing, sheet and plate forms.



Extremely close dimensional tolerances and polish requirements were met by Carpenter in nearly 500 feet of stainless tubing installed in an AEC nuclear power aircraft test facility. Compressed air forces radioactive particles through the tubing, which passes through a 32½ ft. thick concrete wall shielding the reactor. Temperature inside the tubing during operation ranges between 1600° F and 2000° F.



If you are concerned with the design, construction or application of nuclear power equipment requiring tubing and pipe, draw on the broad and extensive atomic experience of Carpenter's technical staff and production facilities. Plan to see our representative soon and send for Bulletin.

9-17-57

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept. The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

For more data circle 530 on Post Card

CONSTRUCTION NEWS

Palo Alto, Calif. — Stanford University has announced plans for new steel and concrete boiler plant and heating system for college campus. Plans by Spencer & Ambrose, 251 Kearny St, San Francisco, Calif., will be placed in work soon at a reported cost of approximately $1,300,000. G. M. Simonson, 507 Howard St, San Francisco, Calif., consulting engineer.

Canon City, Colo. — Southern Colorado Power Co, 115 W. 2 St, Pueblo, Colo., will carry out an expansion program at local steam electric generating plant, with installation of a new 22,500-kw steam turbine generating unit and substation, along with auxiliary equipment. Work is already under way for completion by early 1959. Stearns-Roger Mfg. Co, 660 Bannock St, Denver, Colo., has been awarded the construction contract at a reported cost of $5,000,000.

Glenwood Springs, Colo. — J & J Rogers Company, 120 Wall St, New York, N. Y., manufacturers of bonded papers and newsprint, has announced plans for the construction of new plant for the production of newsprint at local site. Plans include construction of a cinder block, structural steel paper mill along with the general facilities for the manufacture of newsprint. A new steam power house with auxiliary boiler facilities is planned. Work will get under way soon for completion in 1959. Alvin H. Johnson & Co, Inc, 415 Lexington Ave, New York, N. Y., is architect and consulting engineer of the project. Installation reported to be a $7,500,000 project.

Hartford, Conn. — Connecticut Light & Power Co, 36 Pearl St, has authorized plans for the installation of high-power transmission lines in company's system running from Waterbury to Torrington and Watertown, Litchfield, Thomaston to Torrington. Cost reported along with necessary substation installations reported to be in excess of $3,000,000. Company also plans to rebuild and modernize existing 69KV line from Devon generating plant to such areas as Derby, Devon, Orange and Milford at an additional cost of $1,000,000.

Chicago, Ill. — Commonwealth Edison Co, 72 West Adams St, has arranged an expansion and improvement program in plants and system over the next three-year period to cost in excess of $500,000,000. Company plans to expend another $150,000,000 in 1960 for a total of $650,000,000, — a record construction program for the company in a four-year period. A major item in the budget includes the 180,000-kw Dresden nuclear power station near Morris, Ill., along with five other generating units and a 345,000-volt, 90 mile interconnection with the American Gas & Electric system, from Goodings Grove, Ill., to New Carlisle, Ind. Net generating capability of Commonwealth system in 1960 will approximate 5,300,000 kilowatts.

Chicago, Ill. — Commonwealth Edison Company, 72 W. Adams St, has work under way on new one and two-story structure, at Polk and Leamington Avenues, for use as an office and service building. New facility for the Central Division of the company will have a floor area of approximately 78,500 sq. ft. and will cost a reported $1,600,000 when completed. Gerhardt Meyne Co, Chicago, Ill., has been awarded the construction contract. Shaw Metz & Dolio, 208 La Salle St, Chicago, Ill. are the architects.

Newburg, Ind. — Aluminum Company of America, 1501 Alcoa Building, Pittsburgh, Pa., has work under way on new smelting plant 3 miles east of this town. Installation will include construction of 20 buildings of steel frame and aluminum siding, including a two-story office and administrative building. Work will include installation of a large power house, laboratory, transformer and rectifier buildings and machine shop. Project when completed will represent an investment in excess of $10,000,000. Harry Balke Engineering Co, 2330 Victory Parkway, Cincinnati, Ohio, is consulting engineer.

Baltimore, Md. — State of Maryland, Department of Public Improvement, 506 Park Ave, has awarded a contract in the amount of $9,754,885 to the Blake Construction Co, 33 E St, S. W., Washington, D. C. According to current planning, general construction contract calls for the construction of a new State House and Power house.

Albuquerque, N. Mex. — New Mexico Public Service Co, 424 Central Ave, has announced plans for the installation of new transmission line from Albuquerque to Santa Fe, New Mexico, for increased capacity and service and to expand company system. Total cost of this work reported to be in excess of $2,000,000.

Gloucester, N. J. — Public Service Electric & Gas Co, 80 Park Place, Newark, N. J., has authorized plans for the construction of new switching station and installation of auxiliary equipment for increased capacity and service. Installation reported to involve an expenditure of approximately $7,500,000.

New York, N. Y. — Consolidated Edison Co of New York, Inc, 4 Irving Place, plans extensions and improvements in power plants and systems through 1957 to cost about $146,500,000. Company expects to spend $127,705,000 on its electric operations with $57,010,000 set aside for new electric generating stations, $55,200,000 for transmission and distribution lines and $15,495,000 for power substations. Company has also set aside $2,090,000 for steam service in Manhattan, $6,400,000 for underground duct systems carrying electric cables and $3,060,000 for other operating facilities. Consolidated Edison's 1957 budget for construction is the largest expenditure in any one year of the company's history.

Cleveland, Ohio — B. F. Goodrich Chemical Co, a division of B. F. Goodrich Co, 2069 E. 9th St, plans new steam generating plant at proposed new chemical plant. Plant site of 240-acres on the west bank of the Illinois River, near Henry, Ill., has been acquired. Initial construction plans include a processing building, office-warehouse, machine shop and steam generating plant for production of specialty organic chemicals for use in rubber, petroleum, plastics and other industries. Entire project will represent an investment of $5,000,000.

Allentown, Pa. — Pennsylvania Power & Light Co, Ninth & Hamilton Sts, has plans under consideration for new steam electric generating plant, with initial capacity of about 330,000-kw. Work on the unit will begin some time next year. Site on Brunners Island, 15 miles below Harrisburg on the Susquehanna River has been selected for the new plant which is scheduled to go into production early in 1960. Company has announced plans to spend nearly $24,000,000 for expansion this year and an estimated $193,000,000 between now and 1961.

Johnstown, Pa. — Pennsylvania Electric Company, 222 Levergood St, has authorized a 1957 construction budget of approximately $27,000,000, for extensions and improvements in power plants and system, including power substations, transmission lines and other corporate facilities. Company proposes to spend $4,000,000 in the greater Erie area, for construction of a 51-mile transmission line from Erie to Warren, Pa., and a 15-mile loop with substations around the city of Erie. Work on this project will get under way at once for completion in early 1959.

Columbia, S. C. — South Carolina Electric & Gas Co, 328 Main St, plans extensions and improvements in power plants and system for 1957 to cost approximately $29,000,000, including extensions in generating stations, power substations, transmission lines and other operating facilities. The 1957 expenditure is part of a $75,000,000 construction budget through 1959 approved by the company.

Corpus Christi, Tex. — Central Power & Light Co, 120 N. Chaparral St, has announced plans for the expenditure of more than $125,000,000, over the next five-year period for the construction of new generating and transmission facilities in South Texas. Most of the proposed outlay will go for the construction of new power plants and generating facilities, new transmission lines and expanded distribution facilities. New generating units at a cost of $45,000,000 will double the company's present generating capacity of over 530,000-kw by 1961.

Salt Lake City, Utah — Kennecott Copper Corp, 161 E 42nd St, New York, N. Y., has announced a major expansion and improvement program at company's Utah copper division. Plans for the expenditure of $18,000,000 include a large allocation for the construction of a new addition to generating plant at Magna where a 75,000-kw power plant addition is planned at an estimated cost of $16,000,000. Work will get under way soon and is scheduled for completion early in 1960.

South Charleston, W. Va. — Food Machinery & Chemical Corp, San Jose, Calif., has announced a multi-million dollar expansion program involving carbon bisulfide and carbon tetrachloride producing facilities at company's largest chemical installation, Westvaco Chlor-Alkali Division plant. Plans include the modernization of the steam and power facilities, including the installation of modern fly-ash equipment. Complete rehabilitation program, now under way is scheduled for completion in the spring of 1958.

ALLIS-CHALMERS

Water Conditioning

ON THE JOB

Happy Solutions To 4 Typical Water Problems

● Everybody seems to have problems when they use water. It's too pure, or it isn't pure enough . . . or it needs conditioning for the job it has to do. In any case, a specialist is needed. Here are typical examples of Allis-Chalmers water conditioning service, equipment and chemicals at work solving varied water problems.

Drought Adds to Woes of River Water Users

CALIFORNIA—Things looked bad at a paper company when the first water samples came in. In fact, one water conditioning company went so far as to say that the alkalinity of the water could never be reduced to a satisfactory level.

But on the assurance of Allis-Chalmers experts, a de-alkalizer was ordered for boiler make-up water.

In the meantime there was a drought. The drought made the river water conditions even worse than they had been, so that by the time the equipment was installed there was real trouble with alkali.

Allis-Chalmers engineers had an unusually tough problem on their hands. Instruction, experiment, on-the-spot service, and a program of constant control have resulted in production of satisfactory boiler make-up.

Saved $60,000 in New Equipment

LOUISIANA—A low pressure industrial steam plant was being supplemented by a 1250-lb boiler. The question arose—can any of the old water conditioning system be used? Preliminary investigation indicated the need for demineralization equipment to get the desired water quality for make-up in the new equipment.

A survey of the records showed that it would be possible to use condensate from the low pressure system as make-up for the high pressure system. This solution of the problem required less modification of equipment than was originally anticipated . . . saved an estimated $60,000.

Stained Glass Has Its Place, But Not in Nursery

ILLINOIS—A nursery was spraying water over the outside of its glass hothouses to control the temperature inside. The method was effective, but the iron stains from the water were troublesome. Allis-Chalmers water conditioning experts recommended A-C's 130 Series complexing agents. This did the job by preventing the iron from depositing on the glass.

Battle with Algae Ends in Knockout

KENTUCKY—A petroleum company is finding out what a lethal weapon Allis-Chalmers new 120 Series algaecide really is. Previously they used sodium hypochlorite, but their cooling tower algae problems were not solved. Now they have complete control . . . using concentrations of only one-half of what is normally recommended. They also say it's easier to handle and apply, and better in every way, than anything they've ever used before.

Get Help on Your Water Problems

Whether you need chemicals, equipment or service, Allis-Chalmers provides an unbiased recommendation based on over 25 years' experience. No problem is too big or too small. Specialists are located in many cities. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5304

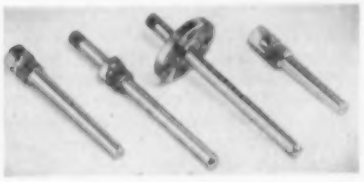
For more data circle 531 on Post Card

EQUIPMENT NEWS

Reader Service Cards on pages 127–128 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—THERMOWELLS protect thermocouples against injury

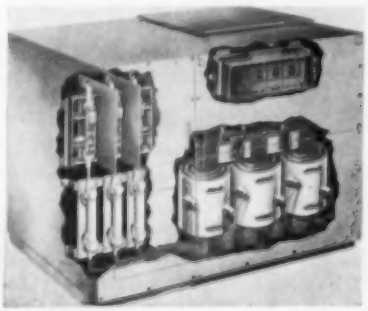
Available in both bar stock and built-up types, T-E Thermowells are said to provide ideal means of protecting thermocouples against mechanical injury and corrosive or contaminating atmospheres. They are offered in over 5700 different combinations — to satisfy most temperature, environmental or installation requirements. Choice of a wide range of alloys provides individual thermowells to meet specific conditions of high temperature, oxidation or reduction, chemical corrosion, metallic amalgamation, mechanical shock or stress, and sudden temperature change. Bar stock wells are available flanged, threaded — with hex head or wrench flats, or with ground joints. Built-up wells of seamless pipe are available with threaded mounting bushings or flanges. Thermo Electric Co., Inc.



2—DISTRIBUTION CENTER offers space saving advantages

This single-unit integral distribution center is announced as requiring up to 42 per cent less space than most distribution centers. It combines in one piece all three sections necessary for load center applications: incoming line, transformer, and outgoing feeder. Designed to pass through normal-size factory doors in an upright position, the unit's installed height is 80 in. — 10 in. lower than usual. For moving purposes the unit is 78 in. high, because the 2-in. high shield over the air vent on top of the center is readily removed. It can be shipped, rolled and installed in one piece. Its dimensions are 37½ to 42½ in. deep and from 56 to 105 in. wide.

The new line is available in four standard ratings from 75 to 225 kva for smaller industrial plants and similar installations. Standard voltage ratings from 208 to 15,000 v may be had. The unit's quiet 56 decibel noise level is 10 decibels under NEMA standards for transformers of similar ratings, according to company. All operations and routine maintenance can be done from the front. Switches, fuses, circuit breakers and taps are accessible through doors or removable panels on the front. The center can be installed as close to a wall as local electrical codes permit. The units have solderless connectors for incoming and outgoing lines. All lines can be brought in from top or bottom of unit. The center is metal-clad with lever-operated air switches. General Electric Co.



3—NETWORK TRANSFORMERS are smaller, more compact

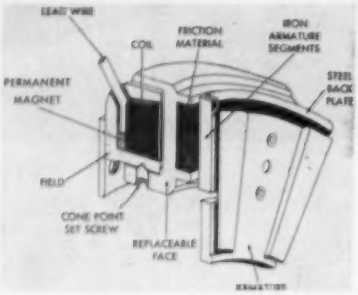
These Space-Miser Network Transformers are announced as 20 per cent smaller than previous designs. Reduced size is claimed to permit savings in cost of vault construction, and substitution of larger ratings in existing locations. Reduced height allows off-the-floor mounting. Elimination of sharp edges and corners by using a curved tank of diving-bell design, and use of hollow, fin-type coolers, instead of tubes, is said to simplify cleaning and painting and reduce corrosion. Sealed rolled-flange, welded low-voltage bushings are available where elimination of gaskets is desired. Similar rolled-flange, bolted-on bushings are available for gasketed applications. Both designs eliminate clamping on porcelain shoulders and are highly resistant to mechanical shock. Westinghouse Electric Corp.

4—DRY ACID COMPOUND for corrosion, rust removal

Drycid is announced as a new powdered acid material which removes rust, scale and corrosion with greater safety to metal surfaces as well as personnel. Added to water in concentrations upwards of 8 oz to the gallon, Drycid is said to go into solution fast and to be useful in applications by circulation or immersion. Solutions may be used cold or, for faster action, heated to 165 F. It is said to be effective in removal of scale, scale-like deposits, rust, iron sulphides and other oxides. Major advantages announced include ease in shipment, as it is shipped in fiber drums; mild, aromatic odor and non-fuming characteristics; and greater safety on aluminum, brass and galvanized surfaces, when used as recommended. Oakite Products, Inc.

5—BRAKES designed to hold the load if power fails

Essentially two brakes in one, Power-Safe Brakes are designed to combine high torque and fast cycling with ability to hold or stop a load if power fails. Power torque ratings range from 125 to 650 ft-lb and fail-safe torque ratings from 33 to 205 ft-lb. Simplicity of operation is announced as an outstanding characteristic of the Power-Safe line. The entire brake has a minimum number of moving parts with none of them in the fail-safe mechanism. There is no



friction on the field or magnets so they never need replacing, company states — all that ever needs to be replaced is the face and the armature, and even these, the lowest cost components, have a long service life.

A major advantage in many installations is the compact design of these brakes. They are mounted with either inside bolt circle or outside mounting flange. With a special adapter, Power-Safe Brakes can be mounted to NEMA C flange and used as a motor brake for a variety of machinery applications. Fast start-stop control for all types of industrial equipment is claimed possible when these brakes are coupled with manufacturer's electric clutch. Warner Electric Brake & Clutch Co.

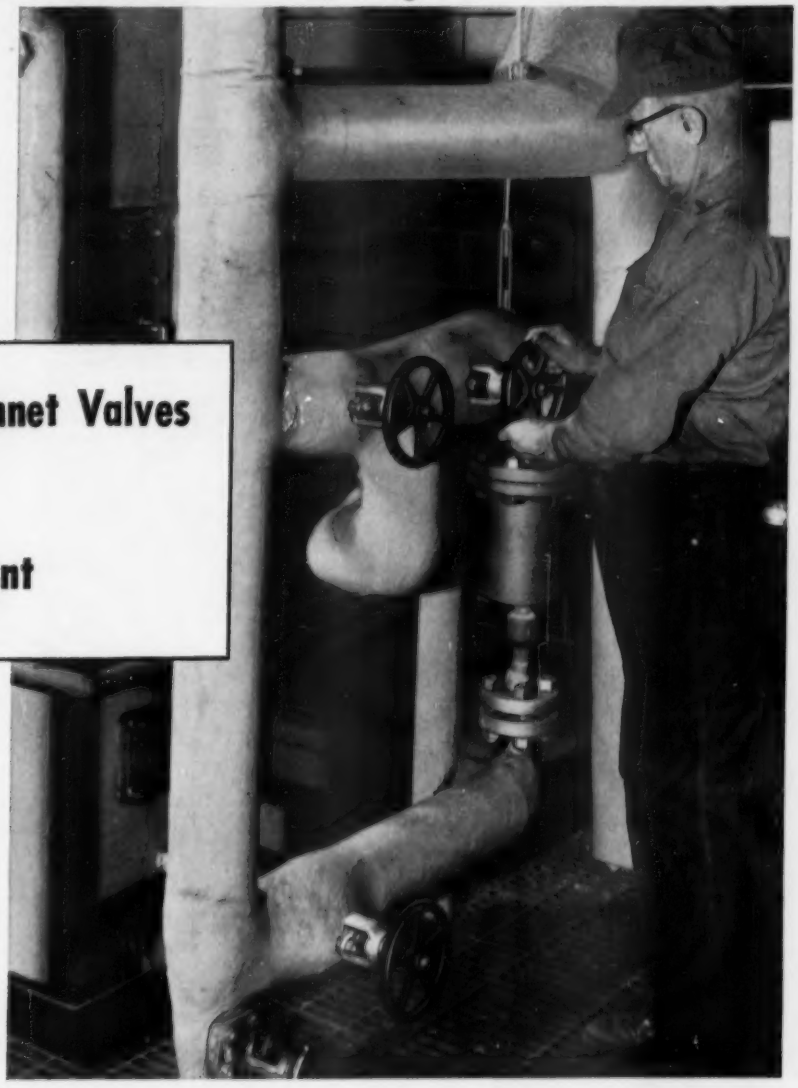
6—BACK PRESSURE VALVE also acts as relief valve

The 1605 is a spring-loaded relief and back pressure valve designed to function on both condensing and non-condensing systems. In condensing systems, valve is used to maintain constant back pressures in exhaust line from an auxiliary engine or turbine. On the condenser of any auxiliary equipment it functions as a relief valve if the vacuum is lost. In non-condensing systems, it serves as a back pressure control valve. Available in sizes 2½ to 6 in., with adjustment ranges varying from 5 to 35 psi, valve is made with bronze, steel or iron body, and offers large discharge capacity and adjustable opening and closing pressures. It can be opened manually and by turning handwheel until spring is no longer under compression, the disc can be lifted from its seat. Seat and disc are of stainless steel or bronze. Valve features deep stuffing box and an adjustable huddling chamber when required. Atlas Valve Co.

7—SUMP PUMP resists corrosion; is portable unit

This self-contained portable sump pump has application in removal of sewage sludge, chemicals, oil, or clean or dirty water from sumps, wells, excavations and similar areas. Body, impeller, and

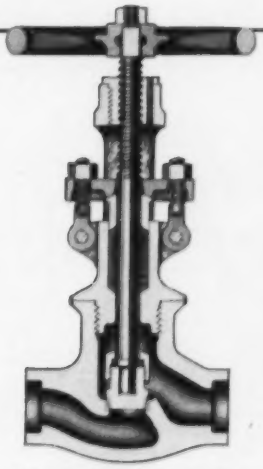
Newest Design in Small Steel Globe, Angle and Check Valves



Crane Lip Seal Bonnet Valves
(patented)

Save Money

for This Power Plant



Central Illinois Electric & Gas Co.'s experience with Lip-Seal valves is typical. Since 1952, this patented Crane small steel valve design for high-pressure/high-temperature service has saved this utility many dollars.

Shown is a 3-valve installation at Sabrooke Station in Rockford on 900 psi steam lines to the ash removal system. In more than 5 years on this tough service, none was given more than minimum routine maintenance—never any attention to bonnet joints.

On other severe services as well, the plant is aware of the continuous good performance and easy care of Lip-Seal valves. More are being installed as other makes give out.

Lip-Seal design features a strong, non-freezing screwed bonnet joint that holds pressure load, with a peripheral weld for tightness only. Weld grinds off easily and repeatedly without damaging joint.

Improved disc-stem connection minimizes vibration . . . provides pilot guiding for the disc. Stellite seating surfaces withstand temperature, corrosion and erosion. Globe, angle and check patterns; 1500- and 2500-pound classes. Sizes ½ to 2 inches. Get full information from your Crane Representative.

Literature on Lip-Seal valves supplied by your Crane Man, or write to address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill., Branches and Wholesalers Serving All Areas

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strainer are bronze, to resist corrosion and assure spark-free operation. As a result, chemical solutions and inflammable or explosive liquids can be handled safely, manufacturer states. Heavy-duty thrust and radial bearings support the two-part impeller, mounted on a stainless steel shaft. Bearings are double sealed to protect them and the air motor from contamination by dirt or corrosive liquids.

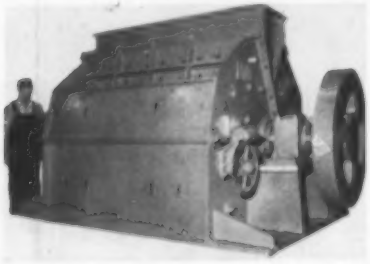
Requiring no priming, the pump is ready for use. It is less than 20 in. high and can be passed through a hole only 9 by 11 in. Liquid over 1¾ in. deep can be picked up; solids over ¾ in. are blocked out by the integral strainer. Pump speeds vary from 3200 to 3600 rpm, depending on head against which it is pumping and the supplied air pressure. A built-in governor serves to prevent excessive speed. Schramm, Inc.

8—PIPE FITTING indicates flow of the liquid inside

Fig. 1366E Sight Flow Fittings are used to indicate flow of liquid in a pipe line. They may be installed horizontally, vertically, diagonally or upside down. Fitting has a spring compensated, hinged, indicator gate which moves in proportion to flow and is visible from either side of the fitting, it is noted, even when the liquid is dark or discolored. Windows are removable for cleaning. Fittings are available in sizes ¾ to 6 in. inclusive, in brass, cast iron or steel — flanged or tapped. They may be supplied with electrical contacts to operate a bell or light if the liquid flow should stop. Contacts are designed for 12-v maximum. Wm. W. Nugent & Co., Inc.

9—COAL CRUSHER is reversible, double action design

For coal crushing and other grinding, this reversible double-action hammermill is said to employ an old principle in a new way to increase life of wearing parts and afford better control of final product size than previously obtainable. Three advantages are announced for it: 1) uniform product size and high capacity



over long periods due to use of double sets of grinding plates and cages with separate adjustments for each; 2) provision for making adjustments while machine is operating, to maintain proper clearance between hammers and grinding plates and between hammers and cages; 3) reduced maintenance costs due to simplified service requirements. It is pointed out that either of two top housings with side plates can be removed without disturbing the feed chute to provide ready access to working parts, and that entire rotor can be removed without moving the feed chute. Capacities are 50 to 750 tons per hour. Williams Patent Crusher and Pulverizer Co., Inc.

10—PARALLEL CLAMPS take large runs, small taps

The demand for heavy-duty parallel groove clamps that will handle the relatively small taps from large runs encountered in primary and secondary distribution has led this company to add new sizes to its series of UP connectors of this type. The additional sizes can connect aluminum, copper, or ACSR. Made of cast aluminum alloy, UP parallel clamps have contact grooves designed to distribute pressure over a wide area so that cables are held securely, but cold flow of aluminum conductors is minimized. Possible vibration failure from chafing of cable at connector entrance is said to be eliminated by a belled mouth. The UP291A26A parallel groove clamp can take taps as small as No. 2 from 266.8 Mcm runs; the UP33R26A, No. 2 from 400 Mcm; and the UP33R291A, from 2/0 to 400 Mcm. Burndy Corp.

11—DAMPER fits into housing of airfoil centrifugal fan

For controlling the air volume and pressure of airfoil centrifugal fans, this variable inlet vane damper is designed to fit into the fan housing. It provides economy of operation by acting as a manual or automatic output control, manufacturer points out. The damper has nine pie-shaped metal vanes mounted in an aerodynamic inlet cone and adjustable at angles from 0 deg when closed to 90 deg when open. When set at desired pitch, the vanes spin entering air in the direction of the fan blade's rotation.

Vane dampers are available for manual or automatic control. For manual control, the vane pitch is selected and linkage locked into position by a hand lever. For automatic operation, an air-driven or hydraulically operated cylinder can be attached to the actuating bolt. The damper comes in sizes to fit fans from 12 in. through 80¾ in. diam. Chicago Blower Corp.

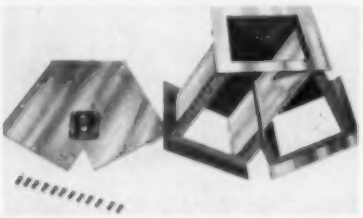
12—PIPE, BLOCK INSULATION for temperatures to 1200 F

Thermasil is announced as a hydrous calcium silicate compound, blended with other inorganic ingredients reinforced with long asbestos fibers. It is a molded insulation, chemically converted to form a strong, hard, light and chemically stable material, company explains, and it is non-flammable and unaffected by water or excessive water vapor. It comes in both sectional pipe form and in block form. The former is available in pipe sizes to 18 in., and simplified thickness standards make it possible for every pipe size and wall thickness to fit over or inside another pipe size. For pipe sizes over 18 in., the insulation is supplied in segmental form. Block insulation comes in 18- or 36-in. lengths.

Thermasil is reported to possess properties which suit it for higher temperature applications: low thermal conductivity strength and light weight; and ease of application. It can be cut, sawed, scored, drilled or nailed with standard tools. For temperatures of 600 to 1200 F, company recommends double layer application. Ehret Magnesia Mfg. Co.

13—PANTLEG CHUTES can be disassembled for cleaning

Buck-El Pantleg Chutes are standardized units equipped with flop gate, and are available for ready attachment to duct work, screw conveyors, bucket elevators or other machinery where a stream of material must be diverted from one direction to another. They come in six nominal sizes from 6 to 16 in., with corresponding dimensions for opening,



flange center distance and height. They are made of carbon steel, stainless steel and other materials. The side of the unit can be removed for cleaning. An optional extra is a lucite side which makes visible the actual operation of the flop gate and the flow of materials. The chute is available with a flop gate that can be worked manually through a tilt bar, or by chains to floor level, or air-operated by means of an air piston. Needle valves to control the speed of the slide included. The Bucket Elevator Co.

14—SWITCH CONTROL is easily installed instrument

To meet a demand for a high load switch, activated by an electronic liquid level control, the Model FLMC is introduced. Mounted in one case, with internal wiring complete, is the electronic control, activated by the level of the liquid in the vat, reservoir, boiler or tank to be controlled, together with a magnetic switch or contactor as an integral part of the instrument. Installation is simple, it is pointed out — all that is needed is the connection of the power and load lines and the single line cable to the electrode in the tank to be controlled. These can be had in styles and capacities for motor starters or magnetic valves. The Lumenite Electronic Co.

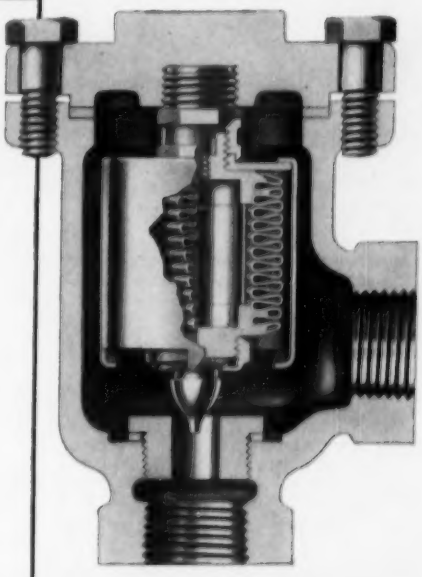
15—NUCLEAR PURIFIER is disposable ion exchange unit

Model XP15 Nuclear Purifier is announced as a disposable package unit which reduces the cost of removing dangerous radioactivity. It is 40 in. high, 15 in. diam, and may be used for cation exchange, anion exchange, or mixed-bed demineralizing. It may also be used with granular activated carbon to filter and to adsorb organic impurities. It is explained that contaminated water is passed through the purifier, where the radioactive ions from the solution are exchanged onto the resin bed for non-radioactive ions from the resin. As a result, the radioactivity from the solution is adsorbed and concentrated on the resin bed, company states,

Proven by performance!

All departments agree on operating efficiency of SARCO Thermostatic Steam Trap

	MAINTENANCE	PURCHASING	STORES
1. **Same head and seat for 0-300 psi** — no changing of heads and seats for varying loads and pressures.	✔	✔	✔
2. **Fewer parts to stock** — same bellows, head and seat for 0-300 psi.		✔	✔
3. **Greatest capacity per dollar cost** — 1" size discharges 9,650 lbs/hr at 10°F below steam temperature, 125 psi.		✔	
4. **Very compact and light** — ¾" size fits in palm of the hand. Weighs only 3¾ lbs.	✔		
5. **Freeze-proof**—wide open, self-draining when cold.	✔		
6. **Only one working part** — the thermostatic element. Can be inspected or replaced in few minutes without moving trap from line.	✔		



SARCO

Balanced Pressure

THERMOSTATIC STEAM TRAP

Same seat and head
for all pressures to 300 psi

•

Sizes ½" to 2"

•

Write for Bulletin 250

Proven by testing!

Steam-tested — every single Sarco Thermostatic is steam-tested at rated maximum pressure.

Proven "on-the-job" performance — maximum fatigue-resistance for every thermostatic element is assured by Sarco's exclusive helical corrugating process and fatigue testing method.

Quality Control — every step of manufacture under exacting tests and controls . . . in Sarco's own plant.

Proven by experience!

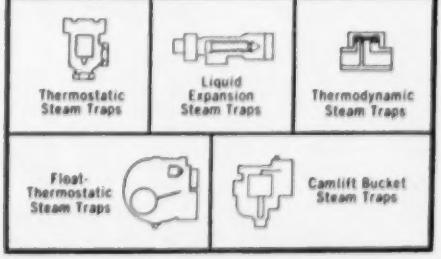
During past 40 years, over 1,000,000 Sarco Thermostatics have been installed in countries throughout the world!

Sarco Company, Inc., Empire State Bldg., New York City

AN AFFILIATE OF SARCOTHERM CONTROLS, INC.

Only Sarco Makes All 5 Types

. . . that's why Sarco can give impartial advice on trap selection



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STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

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and the solution leaving the purifier is essentially free from radioactivity and may thus be safely disposed of or possibly recycled for reuse. Model XP15 is declared simple to install and economical to operate; it is designed for low-cost installation, using snap-joint couplings. The Permutit Co.

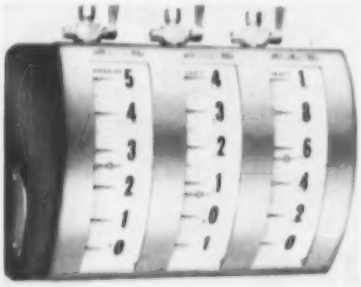
16—FUSE PULLER panel, 150 amp, 12 or 16 branch circuits

Designed for service entrance installations requiring capacity in excess of 100 amp is a new fuse puller panel with 150-amp main lugs. It is available with 12 or 16 plug-fuse branch circuits, and has a total of four fuse pullers. In it, a 60-amp range puller is connected in parallel with a 100-amp puller controlling all plug-fuse branches. Also in series with the 100-amp puller are two 30-amp power circuit pullers. These may be used to protect the circuits for additional 240-v appliances. The new panel is rated for 120/240-v a-c, single-phase, three-wire service and has a groundable neutral. It comes in flush mounted or surface mounted enclosures, and is UL listed.

Installation features announced for this panel include straight-in wiring at all terminals to eliminate looping wire ends, and steel neutral lugs that resist stripping when tightened. To protect the user from accidental contact with live conductors, the enclosure has a dead front design. Silver-plated copper for screw shells, connection points and all other current-carrying parts helps assure high conductivity, cool operation. Snap-action fuse puller blades are provided to prevent partial contacting, give quick-make, quick-break action, and simplify fuse replacement. General Electric Co.

17—MULTI-POINTER GAGES, dry diaphragm, vertical scale type

For applications where easy readability must go hand-in-hand with space-saving installations, these instruments are reported to give an instant, accurate and continuous picture of the flow of air through the boiler. Available in two- or three-pointer models, which may be



combined for multiple installations, the units are used for measuring over-fire draft, outlet draft, first and last passes and windbox pressures. Equipped with big scales of translucent Lucite for interior illumination, and large pointers, the gages are designed to be read from any point in the boiler room with no parallax. Scales are marked with designation desired by user by means of engraved identification name plates. Because of their vertical design, two of these instruments offer space saving advantages. They are made in projected or semi-flush mounting styles. Cleveland Fuel Equipment Co.

18—REEL CART eases wire rope and cable handling

Equipped with a hydraulic jack, this reel cart can be used for several purposes: to transport reels of wire rope and

electrical cable; as a metering stand for paying out cable; as a turntable for large coils; or to lift reel into and out of cable winding machines. The cart does the work, says company; it is able to lift reels weighing up to 1,500 lb. The arms will accommodate reels up to 48-in. in diameter by 32 in. wide. Cart is of steel construction with rubber-tired wheels, and has a foot brake, which locks against front wheels. Columbia Products, Inc.

19—SOLENOID VALVE is bubble-tight at high pressures

Type SBTDW is stainless steel solenoid valve claimed bubble tight even at 5000 psi working pressure. The valve is a small, direct lift, angle type machined from 316 stainless steel bar stock, a construction designed to provide exceptional corrosion resistance. A Teflon seat eliminates metal-to-metal seal and serves to assure bubble-tight operation even with such gases as helium, nitrogen and carbon dioxide. It can be used over a wide temperature range, company adds, is suited to applications where high pressure is combined with relatively little flow. Its direct lift action provides instantaneous opening and closing even with viscous fluids. Pipe sizes are ⅛ and ¼ in. with $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, or $\frac{3}{16}$, in. port sizes. Coils are available in desired voltages. Atkomatic Valve Co., Inc.

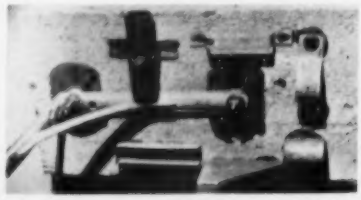
20—POSITION INDICATOR for remote operation of valves

Operation and position-indication of remotely located valves, gates, feeders, or other devices is reported possible with Synchro-Scan Position Indicator-Controller units. They are designed to permit remote modulation and continuous indication of valves or similar devices. This is accomplished through the transmitter package (a plug-in unit) which has a three-position (open, close and off) switch mounted on its face to control the device. Above this switch is a small voltmeter-type indicator graduated from 0–100 per cent to indicate per cent of opening. At the receiving end, another packaged unit contains control relays and regulated d-c voltage supply used to transmit position indication. A standard electric position transmitter is used to originate this voltage. Only two wires and a ground are required for transmission of signal. Builders-Providence, Inc.

21—REEL LIFT for handling cable reels up to 48-in. diam

Increased safety and cable reel lifting capacity are announced for the Model RL31 Reelift. Featuring welded construction throughout, it is designed to raise cable reels up to 48 in. diam and 31 in. wide. Increased safety factor in design is reported to give greater protection against injury, damage and breakage, to make lifting heavy cable reels a simple operation for one or two

men. The Reelift measures 48 in. high and 23 in. by 39 in. on the base. The unit weighs 85 lb. Hykon Mfg. Co.



22—BONDING ALLOY for fastening things to concrete

Steelpatch is announced as an easy-to-use alloy of micronized steel and epoxy resin for fastening conduit, piping, shelving, bracks, wood, and other materials to concrete without special tools or drilling. According to company, the bond formed is usually stronger than the materials bonded, and a single bracket properly applied will support several hundred pounds. The joint is claimed unaffected by heat, moisture and many chemicals. Careful measuring of components isn't required, it is noted, and since consistency is putty-like, rough surfaces can be joined. Manufacturer says Steelpatch can also be used to "glue" steel and other broken machinery parts together, fill castings, repair pipe leaks etc. For small repairs or attachments it is used alone; to cover large open areas it can be reinforced with fiber glass, or other material to hold it in place while it is curing. It comes in 5-oz tubes and larger containers. The Lockrey Co.

23—QUICK RELEASE NIPPLE simplifies joint connecting

This quick release nipple, or Q nipple, is designed for use with company's rotary pressure joints, on paper machines, dry cans, calendars, slashers, rubber mills and similar machines to admit steam or liquids under pressure to rotating rolls or drums. It is said to simplify

Now you can buy a

Bailey-built HEAT PROVER Analyzer

Flue gas analysis with a Bailey HEAT PROVER Analyzer at a furnace stack. Per cent oxygen and combustibles is shown continuously.

CONTINUOUS READINGS OF OXYGEN AND COMBUSTIBLES

The famous Cities Service HEAT PROVER Analyzer, formerly available only on loan, is now manufactured by Bailey Meter Company, and you can buy one outright. With this handy portable instrument, you can easily monitor the per cent of oxygen and combustibles in gases.

The continuous readings from a Bailey HEAT PROVER Analyzer enable furnace, kiln, and engine operators to correct combustion variables before costly losses are incurred. Although it weighs a scant 25 pounds, the HEAT PROVER Analyzer is the key to maximum combustion efficiency. With it, the operator can determine the proper proportion of fuel to air at any time.

The two meters on the analyzer show per cent by volume of oxygen and combustibles on either a 20% range span or a more sensitive 4% range. Temperature of flue gases in degrees Fahrenheit is also shown.

Compared with involved, time-consuming Orsat measurements of flue gases, this new portable analyzer offers these advantages:

1. Simultaneous direct readings of oxygen and combustibles.
2. Negligible time lag between combustion change and reading change.
3. Continuous sampling, analysis, and readings.
4. Convenient measurement of temperature.

Ask your Bailey engineer how you can use this instrument to increase combustion efficiency. Or, write today for more information on how this new Bailey HEAT PROVER Analyzer can pay for itself practically at once. G-39-1

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

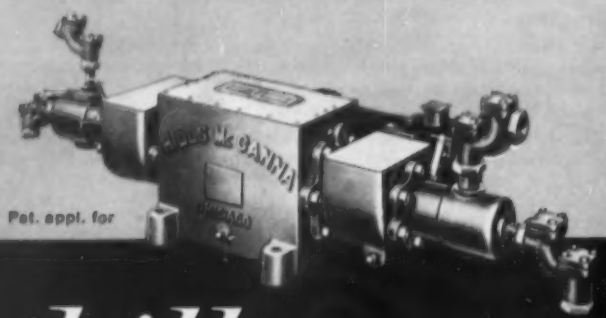
BAILEY METERS

For more data circle 534 on Post Card

Accurate Proportioning of Fluids

Hills-McCanna Metering and Proportioning Pumps

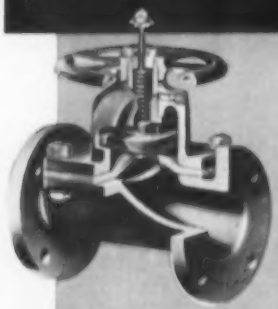
Hills-McCanna Proportioning Pumps are designed for dependable precision metering and simplified maintenance. Ranging in capacity from a few cc to hundreds of gallons per hour, they may be adapted to automatic operation. Write for the valuable booklet "Precision Proportioning Pumps" for complete information.



Pat. appl. for

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW



DIAPHRAGM VALVES

...provide leak-tight, dependable valve performance for corrosive services, slurries, liquids, gases, air and water; feature simplified in-line maintenance, exclusive sealing bead diaphragm. Write for informative catalog on complete valve line.

For more data circle 535 on Post Card

connecting joints to journals of such machines. The nipple consists of three parts — journal flange, tapered split ring and nipple flange. The journal flange is fastened to journal with counter-sunk cap screws. It has a recess into which nipple fits, and threaded studs on which nipple flange is fastened. The tapered split ring is wedge-shaped in cross section, the two halves fitting in nipple recess and bearing against shoulder at bottom of this recess. Nipple flange slides over tapered split ring, and onto threaded studs of journal flange. When nuts on the studs are drawn up, the wedging action between nipple flange and tapered split ring exerts a force to lock nipple in position. The nipple can be disassembled, and joint removed, simply by backing off the nuts, says company, and only a wrench is needed for installation or removal of joints. Johnson Corp.

Described on these pages are new and improved products. Use Reader Service Cards on pages 127–128 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

24—WATER HEATER for use with auxiliary storage tank

Multi-coil Model 500A is described as a compact, water heater designed for use with an auxiliary storage tank in a variety of water heating applications where natural, mixed or manufactured gas is available. According to manufacturer, this heater incorporates fundamental

engineering principles and construction details of company's Model 500, which it replaces. Approval by AGA Laboratories for use as a circulating tank water heater, and by Associated Factory Mutual Insurance Companies for use with sprinkler systems to prevent freezing, is reported. When installed, singly or in multiples, with auxiliary horizontal or vertical storage tanks of 100 to 3000 gal capacity, the Model 500A is said to provide economical and efficient hot water service for commercial and industrial plants and institutions. In certain processes, fluids can be circulated through the unit, it is noted, and it is well suited for tempering water in swimming pools.

Coils and other waterways of the Model 500A are copper. A 2-in. blanket of Fiberglas insulation surrounds the

➔ Take a long look into the future. You'll see constantly growing industrial activity and millions of tons of *power-packed* Bituminous produced to sustain it, with *billions* still in reserve! B&O is a keystone to this vital supply and demand. The coal fields it serves hold proved, usable reserves of billions of tons of Bituminous for every purpose.

Today, tomorrow or decades ahead you may be sure that B&O Bituminous can be *your* best source of stable-low-cost power. It will pay you to use this *fuel with a future* NOW! *Ask our man!*

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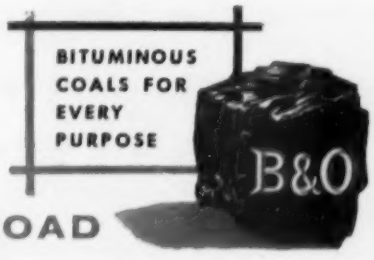
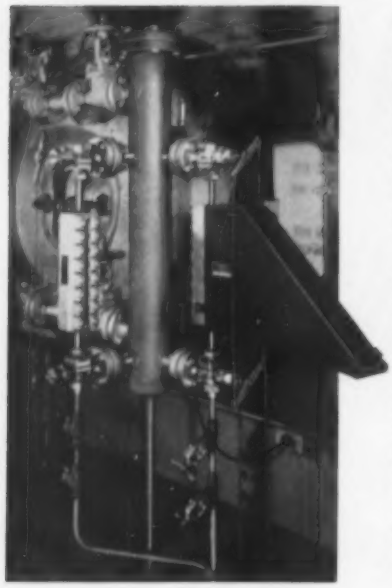


BALTIMORE & OHIO RAILROAD

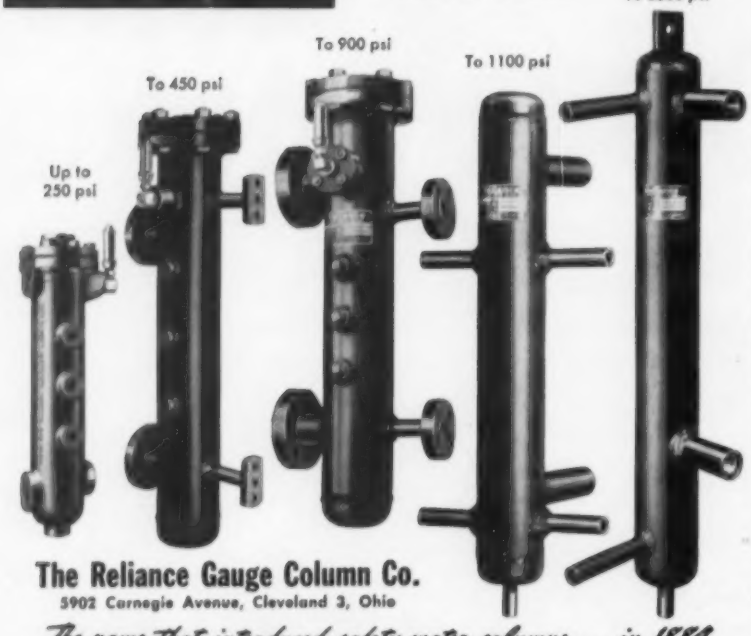
For more data circle 536 on Post Card

Insure safe, continuous boiler operation with **Reliance** Water Columns



Water columns have been around for a long time — ever since Reliance introduced the first one in 1884. Its chief reason for existence then was to carry the float-operated whistle alarm and mechanism, to warn operators of dangerously low water in the boiler. Since then, the water column has been developed in various styles and capacities to meet any power plant need. They are used on most boilers today as an accepted necessity, although many old time engineers — and thousands of young ones — can't explain their full usefulness. If you'd like to know "why a water column", write for free copy of our Liquid Level Letter No. 11.

Reliance makes Water Columns in seven pressure categories, five of which are represented below. And complete "trim" — gage cocks, gage valves, gage inserts, special gages and direct-to-drum assemblies. Write for information on equipment suited to your working pressure.



The Reliance Gauge Column Co.
5902 Carnegie Avenue, Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

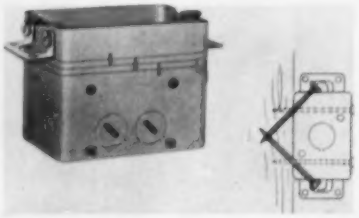
Reliance®
BOILER SAFETY DEVICES

For more data circle 537 on Post Card

combustion chamber and stainless steel flueway and a steel jacket encases the heater. Requiring only 30 by 38 in. of floor space, this heater has a 460,000 Btu input. Recovery rating is given as 645 gph at 60 F temperature rise; 387 gph at 100 F rise. Controls furnished include electric diaphragm gas valve, low voltage transformer, gas pressure regulator, high limit temperature control, aquastat, pressure relief valve and automatic pilot. Ruud Manufacturing Co.

25—SWITCHBOXES offer increased wiring capacity

Many electrical installation problems can be solved by the new non-gangable Redege Series of switchboxes. They are 2½ in. deep, 2 in. wide and 3 in. long, and have a capacity of 12.8 cu in. to permit "through" wiring for a continuous



circuit of No. 14 wire. With this increased capacity, these new non-gangable boxes afford more wires, it is pointed out, and are especially economical for large building tracts. Each switchbox has side scoring for precise wall alignment with markings of ⅝ in., ¾ in. and ⅞ in. depths.

The boxes are square cornered, with nail holes to permit diagonal as well as straight-through nailing. There is a ½ in. knockout in the bottom of the unit, two cable pry-outs in each side and each end. The new series includes switchboxes for loomwire installations which have two non-metallic cable clamps, and units for armored cable and flexible steel conduit, equipped with two armored cable clamps. Boxes are available with ears, with no ears, with stud bracket, and with strap bracket. National Electric Products Corp.

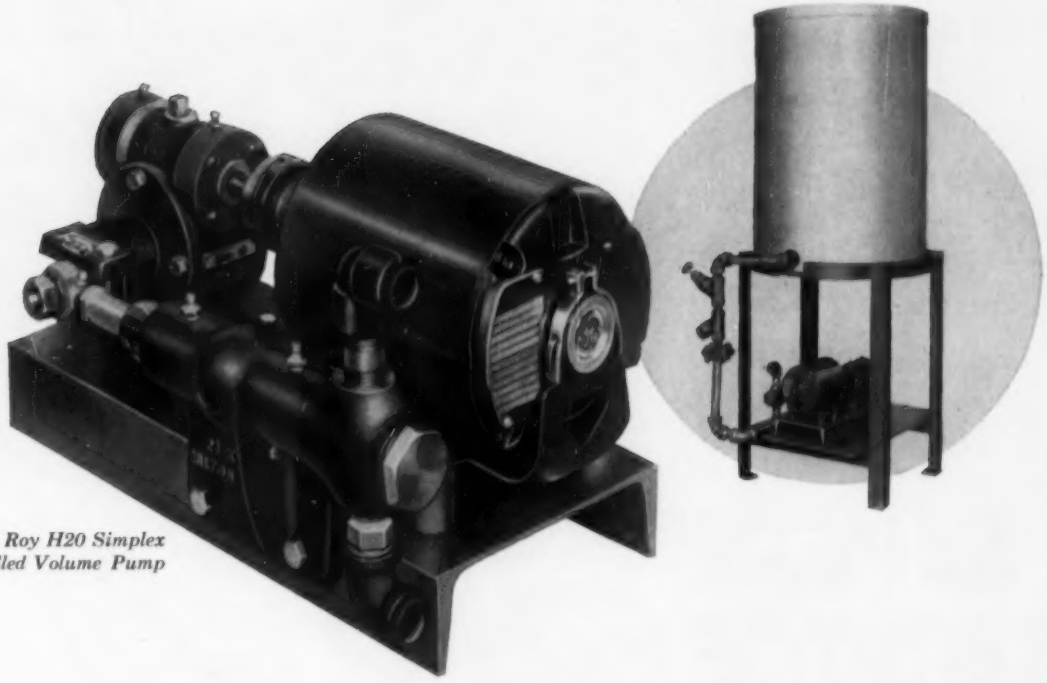
26—RECORDING GAGES come in weatherproof cases

Recording gages for pressure, vacuum and water or liquid level measurements are now available in weatherproof cases, it is announced. The gages are designed for wall or pole mounting outdoors. Measurements of water depths or other liquids can be accomplished with float-type, pressure-type, differential-pressure-type, or bubbler-type liquid level gages; pressure gages are offered in all ranges. Both 8-in. and 12-in. round chart models are available in the new cases; flowmeters and thermometers are also offered. Bulletin L701 gives more details on the gages. The Bristol Co.

27—POWER UNIT converts a-c motors to variable speeds

With the Varidyne Power Unit you can convert a standard NEMA three-phase a-c induction motor from a fixed-speed motor to a variable speed drive without even removing it from its present installation, it is announced. By connecting

Typical packaged system for boiler-water treating ready for shipment includes an H20 simplex pump, a 50-gallon polyethylene tank, suction piping, close-off and relief valves. Standard tanks are available in steel, stainless steel and polyethylene, to hold 50 or 100 gallons. Write for Bulletin 953.



Milton Roy H20 Simplex Controlled Volume Pump

Low-cost Controlled Volume Pumps feed chemicals accurately

High metering accuracy, long service life, minimum maintenance and low cost are the big advantages of Milton Roy H20® Controlled Volume Pumps. They embody quality design features usually found only in higher priced pumps, including: self-aligning bearings . . . self-adjusting packing . . . double ball checks on suction and discharge . . . cartridge-type, easily replaceable valves . . . standard continuous flushing connections.

Both simplex and duplex models are available, and conversion from one to the other can easily be made in the field. H20 pumps can be quickly delivered from stock.

You can depend on H20 pumps to meter boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Write for Bulletin 557 and complete specifications.

Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Asia, Europe, South America, Africa, Australia.

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PRESSURES:
2000 psi
TEMPERATURE
1200°F.

DON'T WORRY

THEY'RE PACKED WITH

JOHN CRANE

SEVERE SERVICE PACKING

Style 177AI

Here is the tough, dependable packing you've been looking for. Style 177AI is built to take punishment . . . to easily withstand pressures as high as 2000 psi . . . remain resilient at temperatures to 1200°F. It's a packing that will give you the kind of service you've always wanted in high temperature valves, soot blowers, gauge glass fittings and similar applications.

Style 177AI is dry graphite lubricated to reduce friction to a minimum. Each strand of the closely braided asbestos yarn top jacket is reinforced with Inconel wire. Core consists of long fibre asbestos and flake graphite.

Available in Spools or in Die-Formed Rings. Rings available with either square cross section or with special bevels for concave-convex nest sets.

Get full information on Style 177AI Packing now. Request catalog describing the full line of "John Crane" Packings.

CRANE PACKING CO., 6429 OAKTON STREET, MORTON GROVE, ILLINOIS (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

For more data circle 539 on Post Card

the induction motor leads to the unit, the motor receives a variable frequency current generated by it. Speeds are changed at the power unit by a hand-wheel or, remotely, by mechanical or electrical remote controls.

The ability to so convert standard motors is reported particularly beneficial for applications where limited space, weight limitations, environmental hazards or other restrictions rule out use of many types variable speed drives. Company says that any open, totally enclosed, explosion-proof or internally geared three-phase induction motor can be converted, and units are available to handle a total connected load of from 1 to 50 hp with speed variations up to 5 to 1. More than one induction motor can be connected to the same power unit and if they are of the same rating, they will change speeds equally and simultaneously. U. S. Electrical Motors Inc.

28—CABLE CLAMPS designed for faster, easier application

Smoother, quicker cable installation is promised by the 480 Series Clamps which can be applied without being dis-

assembled. Nuts are not used, company notes, and an additional timesaver is a universal parallel groove design, making it possible for three clamps to cover full range from No. 2 to 397.5 Mcm in ACSR, and for No. 2 to 400 Mcm in stranded aluminum conductor. Top and bottom parts of clamp are solid aluminum alloy extrusions. Aluminum Company of America.

29—THERMOSTAT designed for corrosion resistant service

Model 18000-26 Thermoswitch Unit is fabricated entirely from 316 stainless steel. For additional corrosion resistance, exterior joints are heliarc welded. Because of its special construction, this unit is claimed especially suited for service in 5 per cent H_2SO_4 at temperatures to 120 F (or in higher concentrations at lower temperatures), acetic acid vapors, halide solutions, alkaline solutions, and other materials to which 316-type stainless is resistant.

The unit is supplied with coupling-head mounting having a ½-14 pipe thread for direct threading into a tank or pipe wall. Contacts open above the control setting. Control temperatures are adjustable over a range of −100 to 400 F, and short-time overshoot by as much as 100 deg will not affect reliability, says company. Current rating is 10 amp, 115 v a-c, or 2 amp, 115 v d-c. The cartridge is ⅝ in. diam, has an immersed length of 3 in. It is designed to control within 2 F. Fenwal Inc.

more Equipment News on page 118

Hall Industrial Water Report

VOLUME 5 JUNE 1957 NUMBER 3

Water Causes Trouble Everywhere

We in the United States do not have a corner on problems connected with water. Consequently, Hall Laboratories through the years has become international. Hall staff engineers now assist in the solution of water problems the world over, working with plants from Newfoundland to Chile and from the West Indies to Europe and the Middle East.

Trouble Shooting In Venezuela

When a Venezuelan utility plant fired up a temporarily idle boiler for service, the operators were surprised to find that a number of tubes were leaking. Further inspection revealed that they were badly pitted.

The surprise of the operators was understandable because boiler water analyses during the work week for the previous 18 months had shown adequate concentrations of alkalinity and sodium sulfite for prevention of corrosion. Furthermore, tests showed dissolved oxygen in the feedwater to be zero.

Hall staff engineer J. E. Summerville made a hurried trip to the plant to determine the cause of the trouble. The pitting nature of the corrosion belied the absence of dissolved oxygen from the boiler feedwater and the presence of adequate amounts of sodium sulfite in the boiler water. Hence, his investigation was directed toward finding out how oxygen was getting into the boilers.

The source of oxygen was quickly located. All boilers were shut down each week end. Air could enter the steam drums when steam pressure dropped. Moreover, with no steam available for the deaerator, any water pumped into the boilers was not deaerated. No water testing was done over week ends.

Changes were instituted immediately to avoid pumping undeaerated water into the boilers and to build up high concentrations of sodium sulfite in the boiler water for week ends. The problem which seemed so puzzling was simply diagnosed and solved because of the specialized experience of the Hall Engineer.

Water is your industry's most important raw material. Use it wisely.

Dirty Cooling Towers Impair Efficiency

Scale formation in the oil coolers and heat exchangers of the recirculating cooling system for diesel engines caused frequent outages and inefficient performance of equipment at an electric generating plant in Haiti. Scale had even formed in the cooling towers.

Untreated city water was normally used as makeup for the cooling system. When it was in short supply, however, water from deep wells was substituted. Analyses indicated to Hall staff engineer A. M. Henricks that both waters were scale-forming in character. He recommended that the water be stabilized against deposition of scale by threshold treatment with Calgon,® supplemented with some sulfuric acid to hold alkalinity of the recirculated water at a satisfactory level.

Algae and bacteria growths in the system were prevented by disinfection with calcium hypochlorite.

Again, trouble-free operation was simply accomplished because of the specialized knowledge and experience of the Hall Engineer.

All Not Left to Kismet

Heavy iron oxide deposits in the boilers of a large Middle East oil company caused many tube failures and costly unscheduled outages.

A study of the problem showed the source of the iron oxide to be corrosion in the condensate return system. Since carbon dioxide in the steam was a factor in the corrosion, some consideration was given to decarbonation of evaporator feedwater with sulfuric acid. However, this would have involved a substantial investment for equipment as well as careful chemical control and operation. Hall staff engineer A. M. Henricks accordingly recommended the use of Hagafilm,® which effectively controls corrosion of metal surfaces contacted by condensate even though the condensate contains dissolved carbon dioxide and oxygen.

The Hagafilm feed did all that was asked of it. It stopped the corrosion and cleaned up the system so effectively that the plant reported "deposits in the boilers have been so light during recent inspections that semi-annual inspections have been discontinued."

Cemented Relations

The heading might apply to the harder-than-concrete complex aluminum silicate scale which was causing loss of boiler tubes in a Colombian oil refinery.

Lake water used in the boilers contained a lot of iron. Coagulation with alum followed by ineffective filtration did not remove the iron. Instead, a considerable amount of aluminum from the alum passed through the filters in the water and went to the boilers causing formation of the complex aluminum silicate scale.

A solids-contact clarifier which had been installed to treat water for a recirculating cooling system was not being used. At Hall's recommendation a few mechanical changes were made to adapt the equipment to treatment of the boiler feedwater. This made possible successful clarification and removal of iron from the water without contaminating the effluent with aluminum.

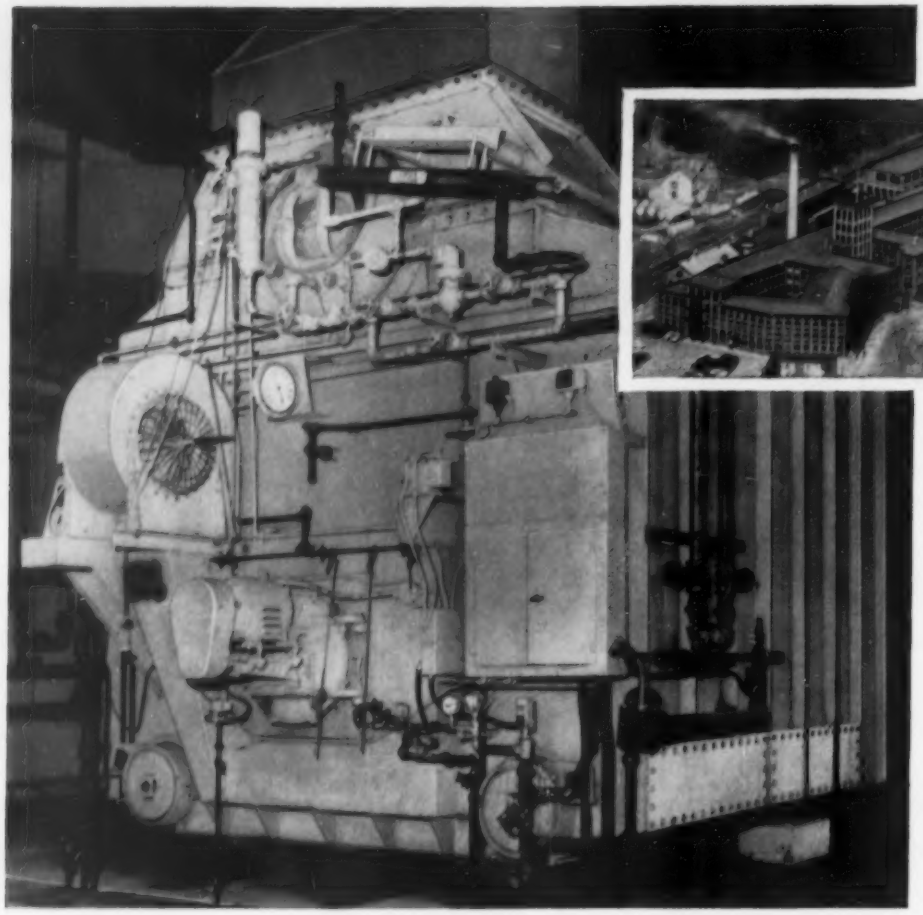
Now, "cemented" applies to relations between Hall Laboratories and the plant rather than to the scale in the boilers.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Division of Hagan Chemicals & Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

For more data circle 540 on Post Card



AERIAL VIEW OF TORRINGTON'S EXCELSIOR PLANT, TORRINGTON, CONN. Torrington is world renowned for its manufacture of bearings, needles, bicycles and metal specialties.

ONE OF TWO UNION TYPE MH PACKAGED BOILERS serving Torrington's Excelsior Plant. Equipped for oil firing, this unit has a steam capacity of 15,000 lbs./hr. at 250 psi.

Torrington racks up $12,500 savings in year with first of two Union Packaged Boilers

Selected because its "construction and design appeared better than others . . . physical size fitted into plans," a 20,000 lb./hr. Union Type MH Steam Generator was installed in the Excelsior Plant of The Torrington Company in October, 1955.

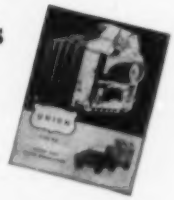
Providing steam for process and space heat, the new boiler quickly proved its worth. In October 1956, as a second MH Unit (15,000 lbs./hr.) was placed in operation, Torrington had this to say about the first: "Estimated savings for the first year are $12,500, as compared to our old coal burning hand fired boilers."

Throughout industry, numerous concerns report like economies as the result of modernizing with modern Union Type MH Steam Generators.

Completely shop-assembled at Union Iron Works for delivery via rail or truck, Union Packaged MH Units are patterned after larger but similar field erected Type H Boilers, originated by Union over 17 years ago.

With standard units designed in 13 sizes from 10,000 to 50,000 lbs. of steam per hour, Union Packaged Steam Generators can be readily equipped to handle multitudes of needs formerly requiring costly field erection and special engineering.

GET FULL DETAILS including cut-away illustrations, tube layouts and dimension tables by writing for Bulletin MH-353.



UNION

UNION IRON WORKS

ERIE, PENNSYLVANIA

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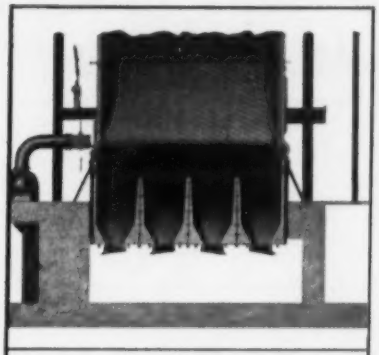
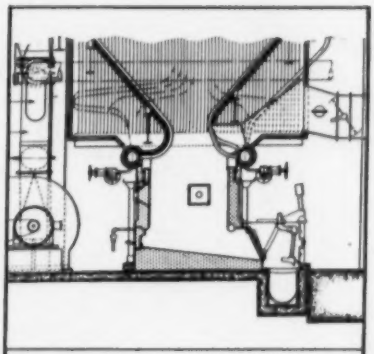
ASHPIT REFRACTORY CASTABLES

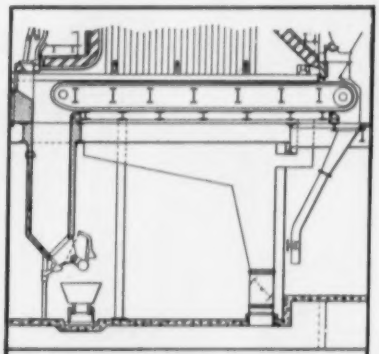
Rugged B&W Kaocretes Stand Up Under Abrasion and Erosion



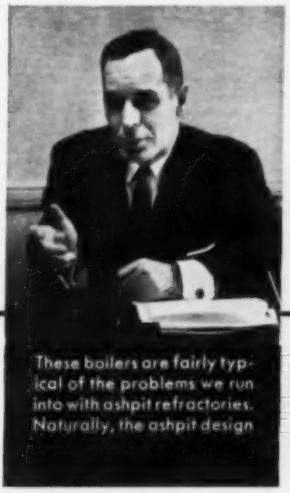
Erosion, due to dry ash sliding down the hopper, is the big problem in this ashpit.



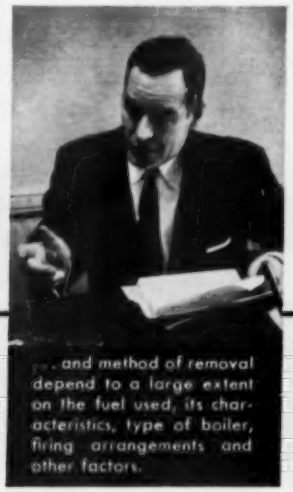
Water jets can cause abrasion of ashpit floor refractories, and water splattered on the walls may cause spalling.



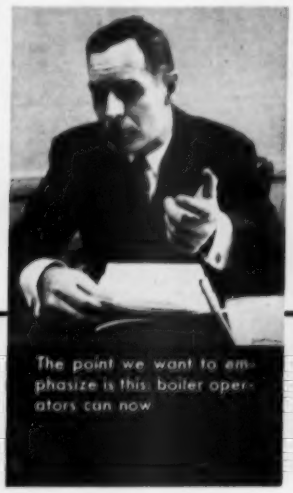
Continuous deposits of ash from a stoker-fired boiler have an abrasive effect on this ashpit lining.



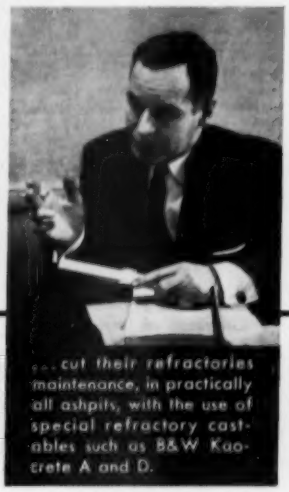
These boilers are fairly typical of the problems we run into with ashpit refractories. Naturally, the ashpit design



... and method of removal depend to a large extent on the fuel used, its characteristics, type of boiler, firing arrangements and other factors.



The point we want to emphasize is this: boiler operators can now



... cut their refractories maintenance, in practically all ashpits, with the use of special refractory castables such as B&W Kaocrete A and D.

How B&W Refractory Castables Cut Ashpit Maintenance

When you consider the punishment ashpit refractories have to take, it's no wonder they are usually the most expensive item of refractories maintenance.

In almost all ashpits, they have to stand up under abrasion and erosion of the ash itself. If the ash is quenched in a water-filled hopper or with sprays, the hot ashpit walls may be splattered with water. The refractories must have spalling resistance to withstand this thermal shock. If the ash is removed by "raking out" or by high velocity water jets, the lining must be able to take this kind of abuse.

How do refractory castables stand up in this kind of service? Here's an example: A public utility made a trial installation of B&W Kaocrete in one of their ashpits. It gave over two years more maintenance-free service than the refractory previously used.

On the strength of this performance, another ashpit was lined with B&W Kaocrete—and this was a tough one. Two opposing high velocity sprays were used for quenching and ash removal. Water splattered on the ashpit walls, which meant the lining was subjected to severe thermal shock. In addition, the jets had an abrasive effect on the floor.

The service was superior to the refractories used before. As a result, this public utility is using B&W Kaocrete to line all ashpits.

These are examples of installation savings made possible by using refractory castables instead of brick. B&W Kaocrete D was specially developed to have unusually high resistance to abrasion, erosion and spalling—properties that are essential in ashpit service. For less severe operating conditions, B&W offers Kaocrete A, which will also give satisfactory service in many types of installations. Your local B&W Refractories Engineer will be glad to give you complete details on the performance of these B&W Refractory Castables.

THE BABCOCK & WILCOX CO.
Refractories Division
General Offices:
161 East 42nd St., New York 17, N. Y.
Works: Augusta, Ga.

R-539

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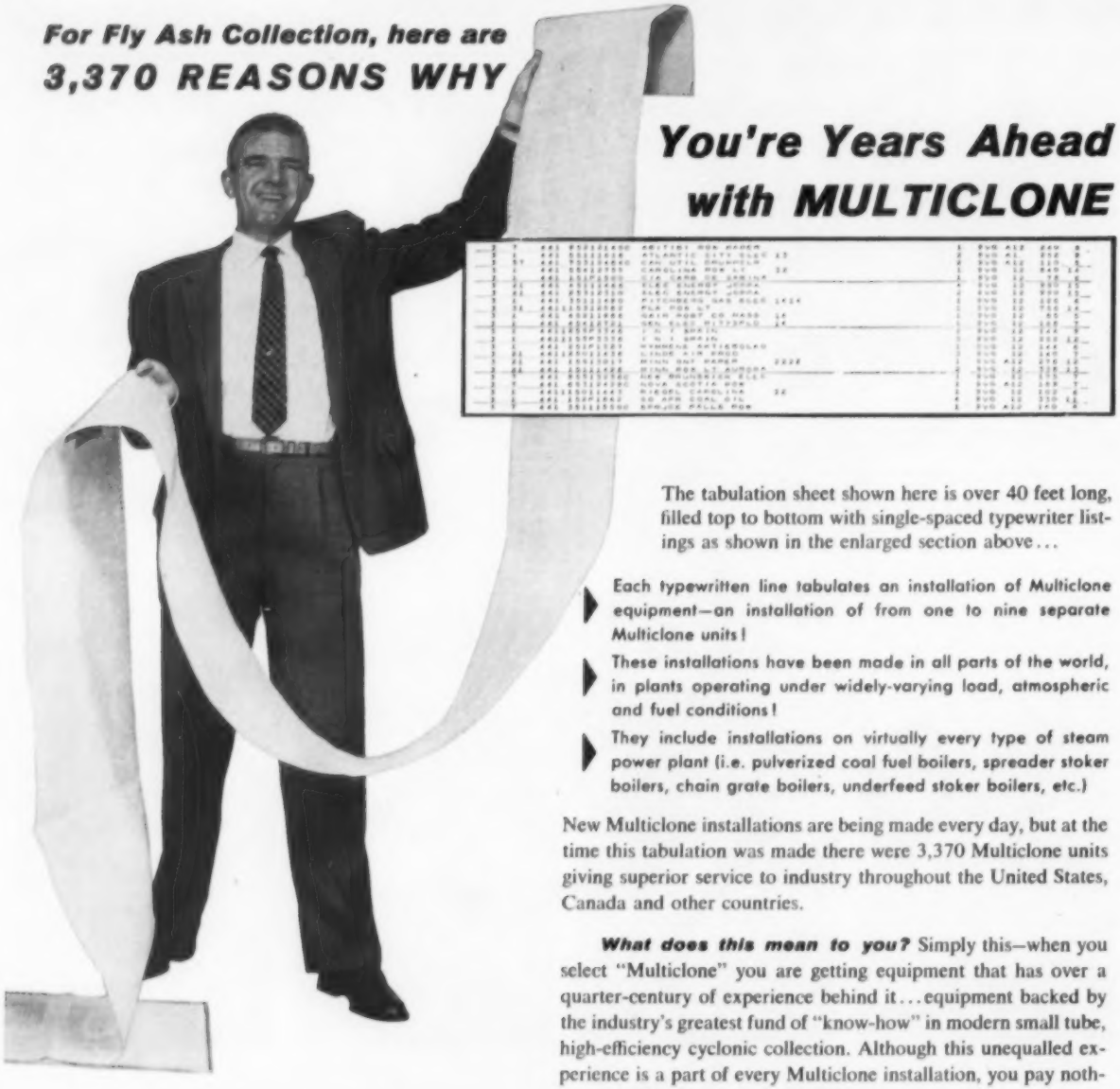
For Fly Ash Collection, here are

3,370 REASONS WHY



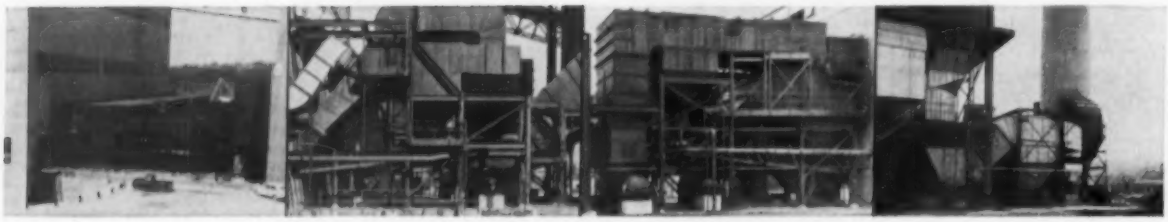
You're Years Ahead with MULTICLONE

The tabulation sheet shown here is over 40 feet long, filled top to bottom with single-spaced typewriter listings as shown in the enlarged section above...

- Each typewritten line tabulates an installation of Multiclone equipment—an installation of from one to nine separate Multiclone units!
- These installations have been made in all parts of the world, in plants operating under widely-varying load, atmospheric and fuel conditions!
- They include installations on virtually every type of steam power plant (i.e. pulverized coal fuel boilers, spreader stoker boilers, chain grate boilers, underfeed stoker boilers, etc.)

New Multiclone installations are being made every day, but at the time this tabulation was made there were 3,370 Multiclone units giving superior service to industry throughout the United States, Canada and other countries.

What does this mean to you? Simply this—when you select "Multiclone" you are getting equipment that has over a quarter-century of experience behind it...equipment backed by the industry's greatest fund of "know-how" in modern small tube, high-efficiency cyclonic collection. Although this unequalled experience is a part of every Multiclone installation, you pay nothing extra for this vital advantage!



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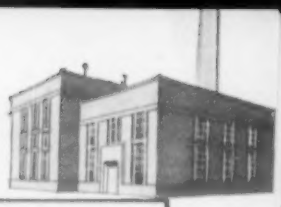
Midwest institution gets lesson in turbine lubrication



...*learns advantages of using* NONPAREIL *Turbine Oil*

In 1939, a Midwestern institution installed a 350 kw. turbine. In less than a year, considerable difficulty was experienced with oil sludge and deposits. A Standard Oil Company industrial lubrication specialist recommended switching to NONPAREIL Turbine Oil as a solution to the problem. He supervised the draining and cleaning of the turbine system and the installation of NONPAREIL Turbine Oil.

The turbine, equipped with NONPAREIL, was started up in June, 1941. Periodic tests showed that the neutralization number of the oil was never above 0.06 mg. KOH/g. Having had this experience with NONPAREIL Turbine Oil, when a new 750 kw. turbine was installed in 1947, only NONPAREIL was considered. In 1954 when a 1,000 kw. turbine replaced the 350 kw. one installed in 1939, NONPAREIL was again the first choice of the institution management.

The reason why NONPAREIL can deliver this kind of performance is this: NONPAREIL is refined from finest quality oil. An oxidation inhibitor is added to NONPAREIL which checks acidity formation even better than natural inhibitors normally found in oil. The inhibiting of acid formation in NONPAREIL is so complete Standard Oil can guarantee that the neutralization number of NONPAREIL Turbine Oil will never exceed 0.15 mg. KOH/g. for the life of the turbine.

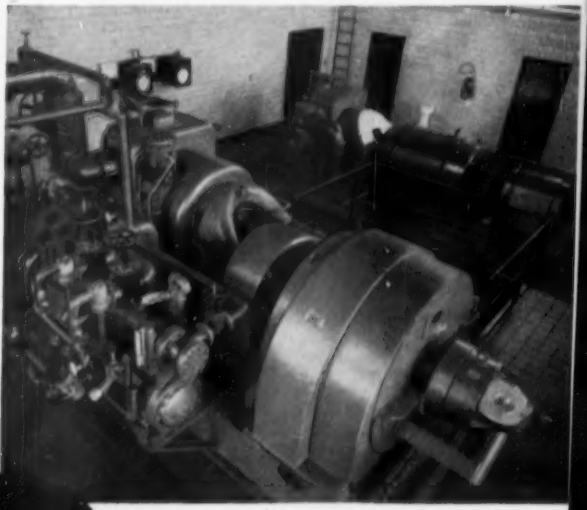
More facts about NONPAREIL Turbine Oil are readily at hand. Get them from your nearby Standard Oil industrial lubrication specialist. There is one of these men in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

Quick facts about

NONPAREIL TURBINE OIL

- Does not form acids.
- Does not sludge.
- Maintains good demulsibility.
- Guaranteed to last the life of the turbine.

A 1,000 kw. and a 750 kw. turbine provide power to this Midwest institution. Both have used NONPAREIL Turbine Oil since the first day they went into service.



Donald Cripps (right), Standard Oil lubrication specialist, hands John Edyvean, plant superintendent, framed guarantee for NONPAREIL Turbine Oil. Providing technical service on lubrication problems is work for which Don Cripps is well qualified. He's been doing it for nine years at Standard. In addition, he has an engineering degree from Michigan State University and is a graduate of the Standard Oil Sales Engineering School.

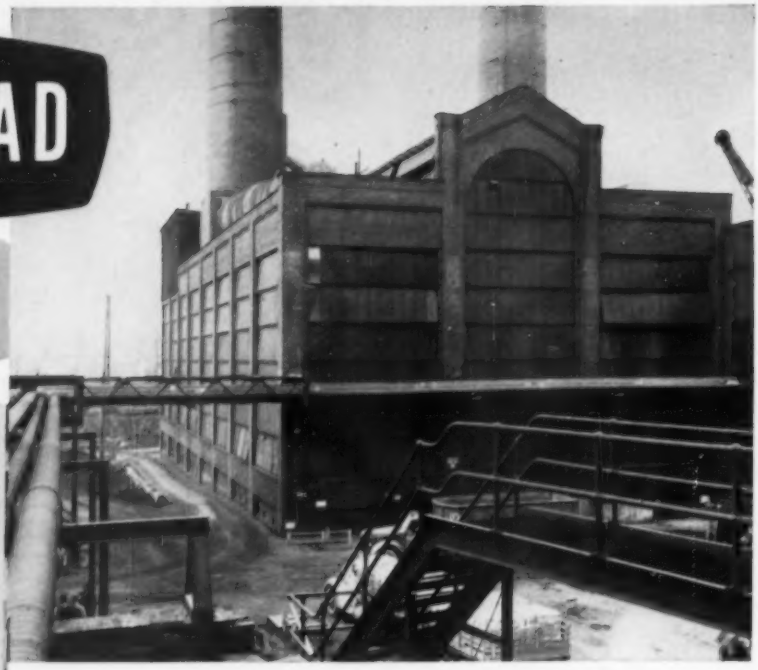
STANDARD

STANDARD OIL COMPANY
(Indiana)

OVERHEAD

OR

underground



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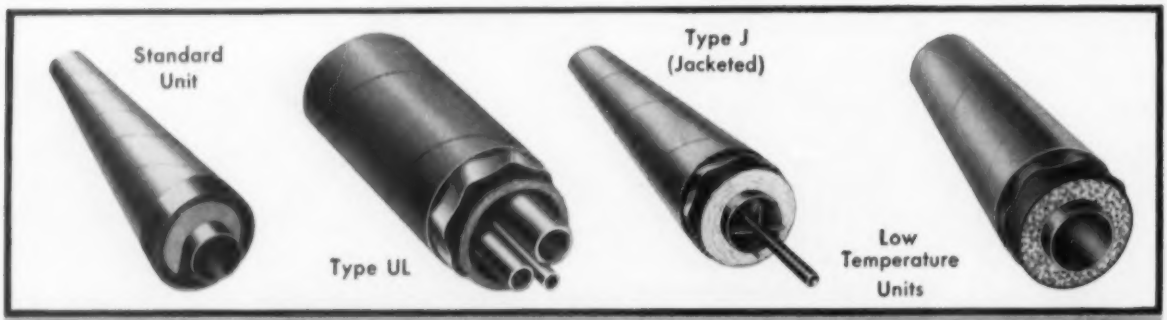

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NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

AI develops reactors for largest power plants and smallest research labs

A wide selection of nuclear reactors, ranging in size from a 75-megawatt nuclear power plant to generate electricity, to a 5-watt laboratory instrument, have already been completed, or are at present under construction by ATOMICS INTERNATIONAL.

The Sodium Reactor Experiment, part of the Atomic Energy Commission's program to develop economical nuclear power, now undergoing tests in the Santa Susana Mountains near Los Angeles, will have an output of 20 thermal mw and will generate about 6.5 mw of electric power. It is the prototype of a full-scale sodium graphite reactor design, which will have a power output of 75 to 125 mw. ATOMICS INTERNATIONAL regards it as a promising reactor type for economical power generation.

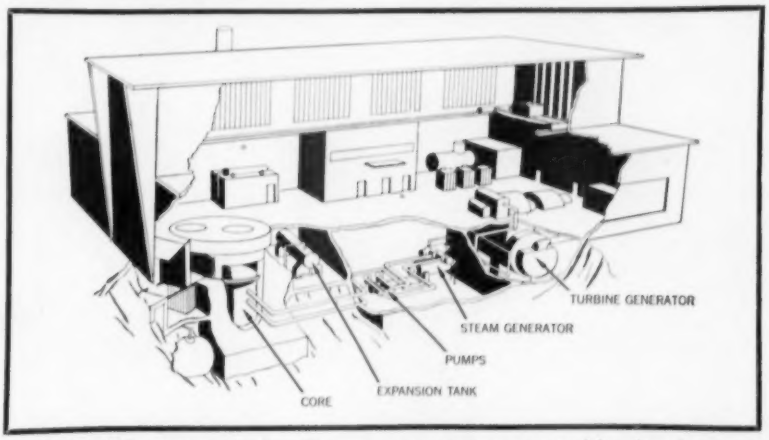
The Organic Moderated Reactor, a relatively new approach to economical nuclear power, is particularly appropriate for smaller plants. ATOMICS INTERNATIONAL is completing construction of the Organic Moderated Reactor Experiment for the Atomic Energy Commission at the National Reactor Testing Station in Idaho, part of a development program for the OMR. Basic advantages of the OMR include compact core with good neutron economy, low pressure coolant system, and freedom from corrosion problems. The OMR is also considered promising for ship propulsion, and ATOMICS INTERNATIONAL is making a design study of this reactor type for maritime use.

Research Reactors are now being built by ATOMICS INTERNATIONAL for Japan, Denmark, West Germany, and West Berlin. They are similar to the ATOMICS INTERNATIONAL reactor now in service at Armour Research Foundation, Chicago—the first to be designed specifically for private industrial research.

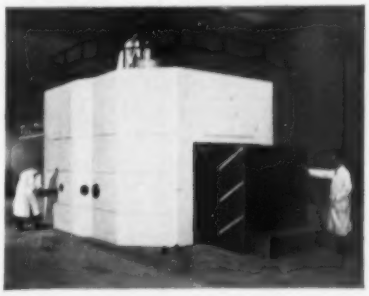
The Laboratory Reactor is a new, low-cost instrument designed specifically to meet the needs of universities and industrial laboratories for nuclear training and research.

ATOMICS INTERNATIONAL, one of America's major builders of nuclear reactors, is staffed and equipped to help you with any phase of reactor development. Please write: Director of Technical Sales, Dept. PE-73, ATOMICS INTERNATIONAL, P. O. Box 309, Canoga Park, Calif. Cable address: ATOMICS.

Reactor "heart". An AI technician installs zirconium "cans" containing the graphite moderator in the core of the Sodium Reactor Experiment. The use of a sodium coolant allows a high-temperature, low-pressure heat extraction system with high thermal efficiency of power conversion.



Typical OMR Central Station Power Plant. Basic advantages of OMR include small size, compact core, low-pressure system, and freedom from corrosion problems. This also makes it a promising reactor for ship propulsion.



Armour Reactor is a 50 kw water-boiler unit for industrial research. It has nine beam tubes for experimental purposes.

Nuclear Nutshell. Laboratory Reactor operates at 5 watts of power and produces more than 100 isotopes. It can be operated by one trained man.

ATOMICS INTERNATIONAL
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PIONEERS IN THE CREATIVE USE OF THE ATOM

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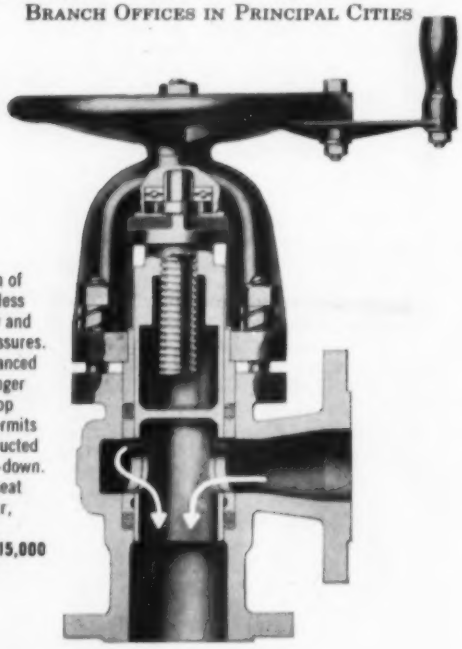
Yarway Seatless Tandem Blow-Off Valve—angle-straightway combination.



Cross-section of Yarway Seatless valve for low and medium pressures. Features balanced nitralloy plunger that seals drop tight—yet permits free, unobstructed flow in blow-down. There is no seat to score, wear, clog or leak. **Used in over 15,000 boiler plants.**

YARWAY blow-off valves

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Your Guide to the Repair and Retubing of

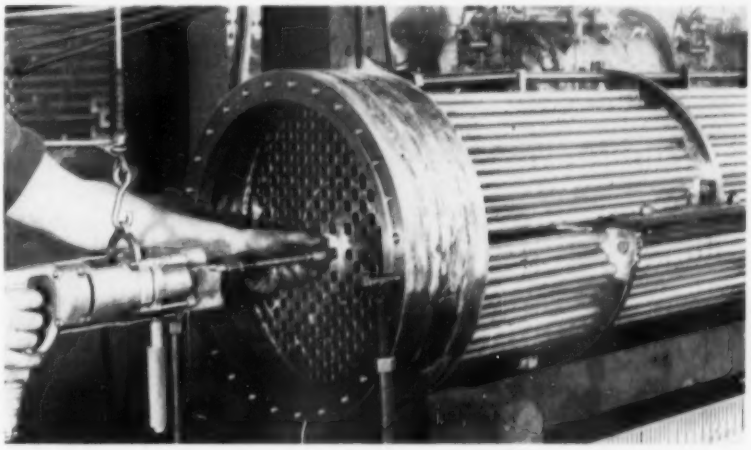
Tubular Heat Exchangers

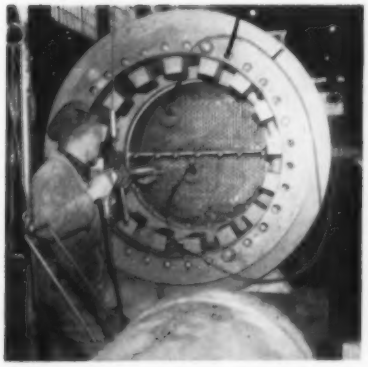
By RAY L. CLAPPER

RAY L. CLAPPER is service manager of the Griscom-Russell Co. of Massillon, Ohio. He is a graduate of Ohio State University (ME, 1918), and joined Griscom-Russell in 1918 as manager of the test department of the Massillon plant. In 1924 he went to New York City to organize a service department for G-R. He moved back to Massillon in 1951. Clapper's duties as service manager have frequently taken him abroad to foreign installations and on trial runs and maiden voyages of many important ocean-going vessels to supervise initial operation of G-R installations. With about 40 years of practical experience in the servicing and maintenance of all kinds of industrial and marine heat exchangers, Ray Clapper may well be considered an expert in this field.

HERE'S PRACTICAL, on-the-job, everyday help on a problem every engineer has. In the six pages that follow, that help is offered to you by one of the top-flight service engineers in the heat exchanger field. He gives you clear directions and detailed diagrams showing how to keep your heat exchangers in tip-top shape.

Whether you are operating a small industrial power and steam plant, a medium-sized one or a large central station, you have to deal with heat exchangers. Every closed feedwater heater, every fuel oil heater, every process water closed heater is a heat exchanger. You may have only one, or a dozen of them in your plant, wherever you have to transfer heat from one fluid to another. We could list many types, but you know the ones you have. The author is dealing here with tubular-type exchangers.





Photograph right above shows an air-driven tube expander (non-automatic) being used on an exchanger tube bundle. In second view the air-driven expander is being used to expand tubes into the tube plate of a high pressure feedwater heater at a central station

These heat exchangers must produce the designed heat transfer, otherwise the entire plant heat balance goes out the window. To keep them fit, use the practical information Ray Clapper gives in the pages that follow (68 to 73).

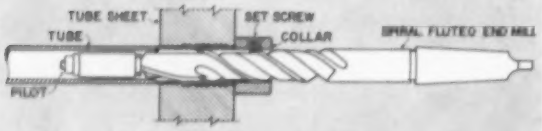
By way of introduction, remember that the successful operation of heat exchanger equipment is largely dependent on the tightness of tube joints. Therefore it is important when replacing an individual tube, or in retubing the entire unit, that great care be taken to select the proper tools and to follow a satisfactory procedure. In this way a secure tube joint will be obtained and the tube nest will maintain its original shape and dimension.

When a complete retubing is required for a unit operating at or above 500 psi, then tube removal and expanding should be done by a mechanic of considerable experience. Otherwise, tube joint leakage may develop, with the result that the tube sheet metal around the tube hole may erode until several tube holes are completely destroyed.

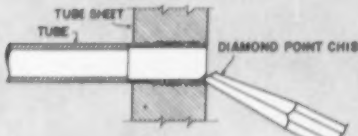
As a general rule, the manufacturer should be consulted before attempting to retube any heat exchanger. But any operators and maintenance crews will find the following procedures and explanations to be valuable guides to any heat exchanger work.

FOR DETAILED INSTRUCTIONS, TURN THE PAGE →

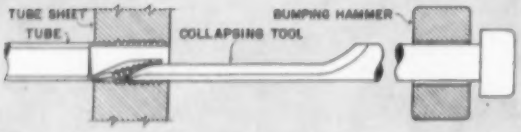
Step 1: Use sizing drill to full depth of tube sheet plus pilot, to clean dirt and obstruction from tube ends



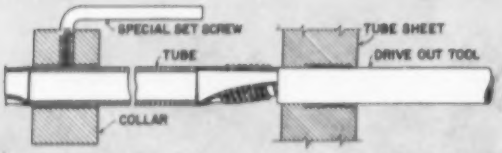
Step 2: Use spiral fluted end mill and drill tube ⅛-in. deeper than tube sheet thickness. For brass or cu. ni. tubes, use approx. 650 to 800 rpm air motor or equivalent. For steel tubes use approx. 300 to 450 rpm air motor or equivalent. Caution—use counter balance to support weight of motor when drilling tube ends, to avoid breaking tools. Use lubricating oil freely



Step 3: Knock edge of drilled tube away from tube sheet to provide easy access of collapsing tool, using diamond point chisel as shown, if necessary



Step 4: Insert collapsing tool between the drilled tube and the tube sheet and drive completely through the tube sheet with light taps. Where opposite end of tube is free, 5th step follows immediately, but where it is secured in rear tube sheet, steps 1 to 4 must be repeated at rear sheet before tube can be knocked out



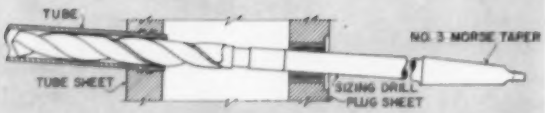
Step 5: Insert drive out tool against the collapsed end of the tube and drive tube from tube sheet

Step 6: Pull tube out through other tube sheet using collar with special set screw, as indicated above, and hammer if necessary

This procedure is for tubes ⅝-in., ¾-in., and 1-in. OD. These tools are suitable for tube sheet with 4-in. max. thickness. Note also that these tools are designed to completely remove straight tubes from tube sheets, the outer face of which is unobstructed by heads or channels. Similar tools of special design may be constructed for drilling out only one tube end and for reaching tube ends through channels

Patent Notice: "Method Patent No. 2411246"

Fig. 1. Procedure to follow for removing tube from tube sheet



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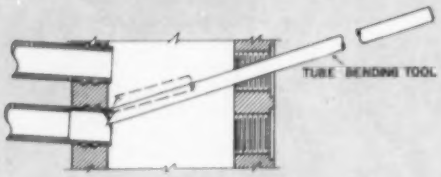
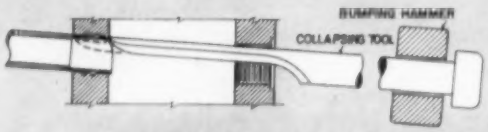


Step 3: Use tube bending tool as shown above to knock edge of tube over, if necessary. Then change tool to position shown in dotted line and knock tube over enough to provide easy access of collapsing tool



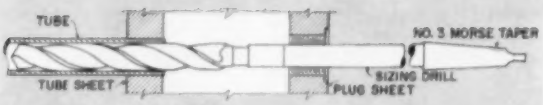
Step 4: Insert collapsing tool between the drilled tube and the tube sheet and drive completely through the tube sheet. Where opposite end of tube is free, 5th step follows immediately, but where it is secured in rear tube sheet, steps 1 to 4 must be repeated at rear sheet before tubes can be knocked out

Step 5: Insert drive out tool against the collapsed end of the tube and drive tube from tube sheet

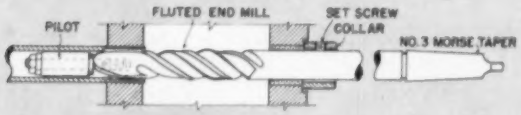
The fluted end mill is good for any header having an outside face-to-face width of not more than 9¾-in.

Patent Notice: "Method Patent No. 2411246"

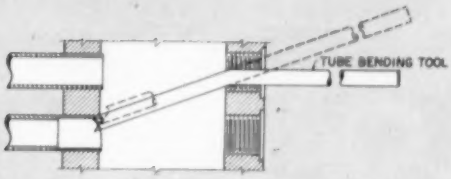
Fig. 2. Procedure for removing tube from bentube header



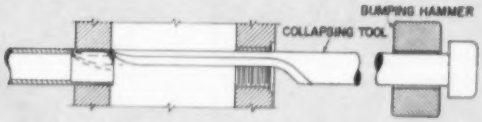
Step 1: Use sizing drill to full depth of tube sheet plus pilot, to clean dirt and obstruction from tube ends



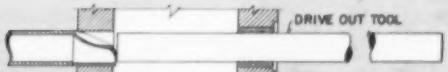
Step 2: Use spiral fluted end mill and drill tube ⅛-in. deeper than tube sheet thickness. For brass or cu. ni. tubes use approx. 650 to 800 rpm air motor or equivalent. For steel tubes use approx. 300 to 450 rpm air motor or equivalent. Use lubricating oil freely



Step 3: Use tube bending tool as shown above to knock edge of tube over, if necessary. Then change tool to position shown in dotted line and knock tube over enough to provide easy access of collapsing tool. Use bent tool for ⅝-in. OD tubes. Use straight tool for 1-in. OD tubes



Step 4: Insert collapsing tool between the drilled tube and the tube sheet and drive completely through the tube sheet. Where opposite end of tube is free, 5th step follows immediately, but where it is secured in rear tube sheet, steps 1 to 4 must be repeated at rear sheet before tube can be knocked out



Step 5: Insert drive out tool against the collapsed end of the tube and drive tube from tube sheet

For use on tubes of ⅝-in. or 1-in. OD. The fluted end mill is good for any header having an outside face-to-face width of not more than 9¾-in.

Patent Notice: "Method Patent No. 2411216"

Fig. 3. Procedure for removing tube from straight tube header

TUBULAR HEAT EXCHANGERS . . . 1

How to remove tubes and replace with new or old or salvaged tubes

WHEN REMOVING defective tubes, the tube metal must be completely loosened from each tube sheet. The tube will then pass easily out through the baffle assembly and tube sheet hole. Any attempt to drive the tube out before it is properly loosened will result in stoving the tube wall, thus increasing its diameter so that it will not pass through the holes in the baffles or support plate.

When loosening the tubes from the tube sheet, the surface of the tube hole must not be scratched or gouged; otherwise, it will not be possible to roll the new tubes satisfactorily. See Figs. 1–3 for procedures.

After the old tubes have been removed, all tube sheet holes should be carefully examined for surface condition and cleanness of grooves. If necessary, a reamer of slightly larger diameter should be used to refinish or to remove imperfections on the tube hole.

New Tubes

Before assembly in tube sheets, all new tube ends should be examined for die marks or scratches and properly cleaned and polished. When the new tube has been placed in the tube sheet hole, one end may be drifted slightly with a tapered pin to keep it from rolling with the expander. Select a suitable roller expander constructed for the proper tube diameter and tube gage. Roller expanders of some manufacturers are designed to roll tubes through all thicknesses of tube sheets. This type of expander will travel forward as the cage and expanding pin revolve in the clockwise direction. A stop collar gages proper depth of rolling.

Roller expanders can be operated by hand power, using a standard carpenter brace. However, this procedure is slow and should only be used when replacing a few tubes. For complete retubing, a suitable lightweight reversible air motor is desirable. A forward speed of about 300 rpm will be satisfactory.

For tube sheets up to 2 in. thick, the tubes will be securely rolled through the full thickness up to ¼-in. of the back edge of the sheet. Never allow the rolls to pass the back edge of the sheet. This will result in bulging of the tube wall, preventing withdrawal through the baffle assembly or the tube sheet hole. It may also cut the tube wall and cause the tube to crack off after it has been put in operation. Tube sheets thicker than 2 in. should first be lightly rolled up to ¼-in. of the back of the sheet, then securely rolled for a depth of 2 in. only.

Old or Salvaged Tubes

New tubes are generally purchased in commercial temper, which is a satisfactory degree of hardness for properly rolled tube joints. When using tubes from old stock or when using salvaged tubes, it is sometimes necessary to re-anneal the tube ends for proper expanding, otherwise the tubes may split during the rolling operation. If this should be found necessary for Admiralty metal or red brass tubing, the tube ends should be brought up to a temperature of 900 F, held at that temperature for 20 min and then allowed to air cool.

If plain steel or carbon moly steel tube ends require annealing, the proper temperature will be 1150 F for 20 min and then air cooled. For chrome moly tubes, care must be taken to prevent air hardening during the cooling operation. The metal should first be heated to 1450 F, then furnace cooled, not exceeding an ambient drop of 50 F per hour, down to 1300 F, followed by a furnace cool, not exceeding a 100 F drop per hour, down to 1000 F. The reduction from 1000 down to room temperature may be done in still air.

FOR CORRECT TUBE ROLLING, PLEASE TURN PAGE

ROLLER EXPANDERS gradually work their way into the tube sheet, but will become very tight after about 1-in. travel. For tube sheets over 1-in. thick it is, therefore, general practice to "step roll" after the expander travels far enough to become tight on the expanding pin. The rotation of the expanding pin is reversed to loosen the expander. The expander cage is moved forward from the original position about ¾-in., the expanding pin tightened, and a second step of about 1 in. is rolled. This procedure may be repeated one or more times, depending on the tube sheet thickness.

Rolling Tubes At Both Ends

When tubes must be rolled in tube sheets at both ends, an expanding procedure must be followed that will keep all tubes straight and prevent bowing of individual tubes or twisting of the tube bundle. This condition is the result of the roller expanders causing the tube metal to "flow" inward, thereby causing the tube to bow between sheets to compensate for the slight increase in tube length.

Single Tube Sheets

The tightness of the roller expanding operation must be governed entirely by the experience of the operator. Do not over-roll the tube ends, because it may result in damage to the tube metal, warpage of the tube sheets and possible damage to the tube expander equipment.

When driving tube expanders or tube removal tubes with an air motor, be sure to use a counterweight to take the weight of the motor from the operator. This will permit better alignment of the motor and tools with the tube hole and thus prevent frequent breakage of tools. Tools should be kept clean and well lubricated with a good grade of cutting oil.

Step Forward Rolling

It is general practice to expand the tube ends as follows. First step, Fig. 4, shows a roller expander in proper position in a tube joint for starting the *step forward rolling* operation. The rolls are generally about ⅞-in. long, and should be so placed that ½-inch of the roller is within the tube, leaving ⅜-in. projecting. At this setting, the roller expanding operation is started by holding the cage in one hand and forcing the expanding pin forward with the other hand until it is tight against the rolls. Turn in a clockwise direction and continue until the rolls are tight and flush with the end of the tube.

If a retubing job is being done, the tube holes may be slightly oversize and, therefore, the rollers may go ⅛-in. or more within the tube before making it tight. This completes one step of rolling forward. Reverse the expanding pin to loosen the expander, then reset the cage as in the second step (Fig. 4) with rollers ¼-in. further in the tube than the final setting of the first step; then rotate the expanding pin in a clockwise direction until it again becomes tight.

Depending upon the thickness of the tube sheet, this step rolling procedure may be repeated until at the end of the last step the forward end of the rollers is within ¼-in. of the back edge of the tube sheet. This step should be gaged by proper setting of the stop collar, as illustrated in Fig. 5, first step.

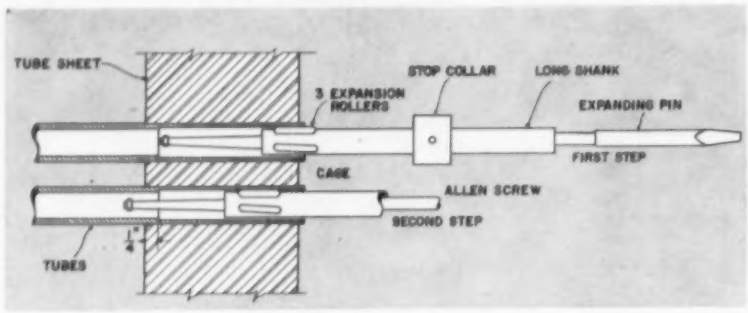


Fig. 4. Roller expander in proper position for starting step forward rolling action

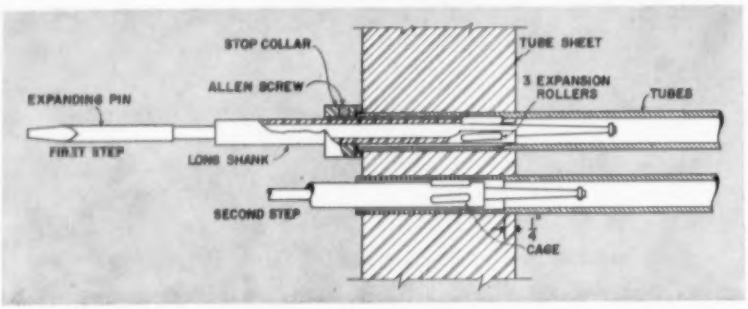


Fig. 5. At the opposite tube sheet, the tube end is expanded by step back rolling

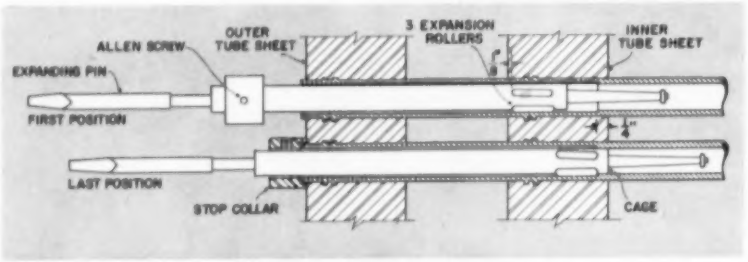


Fig. 6. This procedure applies to exchangers constructed with double tube sheets

Step Back Rolling

At the opposite tube sheet, Fig. 5, the tube end is expanded by *step back rolling*. For the first step, locate the stop collar on the expander cage so that the distance from the face of the stop collar to the ends of the rollers is equal to the thickness of the tube sheet minus ¼-in. as in first step, Fig. 5.

Insert the assembled expander into the tube so that the ends of the rollers are about ¾-in. from the back face of the tube sheet, as in second step; then force the expanding pin forward holding the expander cage stationary until the taper portion of the expanding pin contacts the rollers. Turn the expanding pin in a clockwise direction until the tube is anchored in the tube hole and the stop collar is up against the face of the tube sheet. This procedure will hold the tube in tension and prevent bowing during the succeeding step back rolling operations.

Loosen the expanding pin by reversing the direction of rotation and pull the rollers and cage forward to

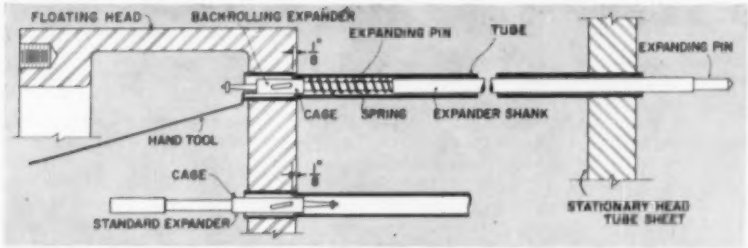


Fig. 7. Back rolling expander, for units with head flange overhanging tube ends

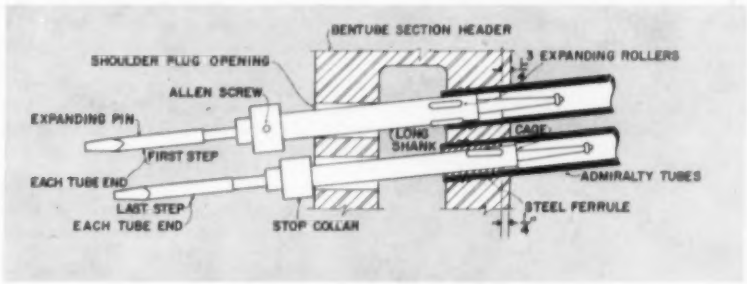


Fig. 8. Standard long shank expanders expand bentubes in box-type headers

take a new bite, or setting, approximately ¾-in. in advance of the original setting. Tighten the expanding pin in the rollers and roll forward to overlap the previous rolling about ⅜-in. Repeat these step back rolling operations until the forward face of the tube sheet is reached. The number of such steps will be determined by the thickness of the tube sheet.

Double Tube Sheets

When exchangers are constructed with double tube sheets, as illustrated in Fig. 6, then the tube ends should always be expanded in the following manner:

Locate the stop collar on the expander cage so that the distance from the face of the stop collar to the end of the rollers is equal to the distance from the face of the outer tube sheet to the back of the second tube sheet minus ¼-in., as in the first step, Fig. 6.

Insert assembled expander into the tube so that the ends of the rollers are about ¾-in. from the back face of the second tube sheet, then force the expanding pin forward, holding the cage stationary until the tapered portion of the expanding pin contacts the rollers. Revolve the expanding pin in clockwise direction until the tube is anchored in the hole and the stop collar is up against the face of the tube sheet.

Reverse the direction of rotation of the expanding pin to loosen the expander, then relocate the rollers to take a new bite about ¾-in. in advance of the original setting. Proceed to roll forward as described above and repeat these step back rolling operations until the full thickness of the inner tube sheet is roller expanded. The number of steps required will depend on the tube sheet thickness.

Care should be taken not to roller expand that portion of the tube between the two tube sheets. The last position of the rollers for completing the rolling of the tube in the inner sheet is shown on Fig. 6.

After all tube joints have been securely rolled in the inner tube sheets at both ends of straight tubes or U-tubes, then reset the stop collar so that the distance from the face of the stop collar to the end of the rollers is equal to the thickness of outer tube sheet minus ¼-in., then proceed to roll all tube ends in the outer tube sheets by the step back rolling operations.

Back Rolling

Some heat exchanger units are built with the head flange overhanging some of the outer tube ends, making it impossible to expand those tubes with a standard expander. For this duty, a back rolling expander shown in Fig. 7 is used.

The expander is inserted through the tube from the stationary tube sheet. An expanding pin extending through the full length of the tube is operated from the opposite end. The method of operating the expander is exactly as described under step forward rolling except that a second man is required to insert a hand tool in the tube end to hold the expander cage in the proper location so that the expanding pin will contact the rolls to begin the rolling operation. The offset end of the hand tool must be of correct length to cause the back end of the rolls to start the rolling operation about ⅛-in. in from the back edge of the tube sheet. All tubes not in the outer area under the overhanging flange can be roller expanded with the standard tube expander.

Bentubes and Air-Cooled Sections

Standard long shank expanders are used to roller expand bentubes in box-type headers as shown in Fig. 8.

The rolling operation for both ends of the tubes will be step forward rolling. A stop collar will serve only to gage the actual depth of rolling and it should be so set that the distance between the stop collar and the forward end of the rolls will be equal to the width of the box-type header minus ¼-in.

Insert all tubes in the tube holes, allowing about ⅛-in. of the tube to extend beyond each tube sheet. All tube holes are drilled to an angle to conform to the cold bow of the tube. Peg all tubes at one end; then, when each tube is pulled to its proper cold bow position, it should be pegged at the opposite end. With the tubes fixed in their proper position, both tube ends may be securely rolled by the step forward rolling operation.

For operating temperatures above 366 F, steel ferrules are expanded in the steam inlet ends of Admiralty or Arsenical copper tubes of bentube evaporators in order to prevent loosening of the tube joints due to the effect of the high temperatures at the tube ends.

The tube is first roller expanded at both ends as described above. A steel ferrule is then placed in position. The end of the ferrule should be flush with the end of the tube, as seen in Fig. 8. If the tube end has not been over-rolled, the steel ferrule will fit tight enough to require forcing it into position so that it will not rotate with the roller expander. If the tube end should be slightly over-sized, it will then be necessary to expand the steel ferrule slightly before inserting it in the tube end.

When the steel ferrule is in its proper position, it is then roller expanded by the same procedure as used on the tube end, except that a smaller-sized expander cage must be selected to fit the inside diameter of the ferrule. The steel ferrule is expanded throughout its full length. The length of the ferrule will be equal to the thickness of the tube sheet up to a maximum of 2 in. Thereafter the ferrule length will not exceed 2 in.

Straight Bare Tube

The procedure for rolling of straight tubes in box-type headers is as follows:

With tubes properly spaced in each tube hole, peg one end of each tube with a drift pin so that it will not revolve with the expander.

Roller expand the first end by the step forward rolling operation. At the opposite end the roller expanding should be done by step back rolling. This procedure will keep all tubes straight and prevent unequal stresses in adjacent tubes.

WHEN AN EXCHANGER requires complete removal of all tubes for retubing, it is then desirable to remove the tube bundle from the shell and cut all tubes off near the tube sheet. This can be done very quickly by burning the tubes off with a burning torch. At one end, burn off pieces 1 ft or more in length, to avoid bending the tube. Continue at that end until the tube sheet is cut free of the tubing. At the opposite end burn each tube off near the tube sheet and then pull that tube back through the baffle or tube support assembly. Brass tubing can be burned away as easily as steel.

Set each tube sheet on a drill press and thin the tube wall throughout the full depth of the tube sheet by using a standard drill approximately 1/32-in. smaller in diameter than the OD of the tubes. This will protect the tube sheet from being scored as the high-speed drill passes in and out of each tube hole. Use the collapsing tool of the tube removal set, shown in Fig. 1 (page 68), and remove all remaining portions of the tube ends. Examine each tube hole for an imperfection and, if necessary, ream the hole to a slightly larger diameter. See that all metal particles are removed from the grooves in the tube sheet.

A complete set of tube removal tools is particularly useful in removing one or more defective tubes from a tube bundle. However, the above procedure will save considerable time in a complete retubing of an old unit.

Bundles for Complete Retubing

When assembling U-tube bundles, it is essential that all U-tube elements are properly spaced so that the metal of one tube will not bear against an adjacent tube. As each element is installed through the baffle assembly and tube sheets, then both tube ends should be tight enough to keep the element in a fixed position during the roller expanding operation.

After all elements are properly spaced and pegged, the tube ends may then be roller expanded by the step forward rolling operation.

Straight Tube Construction

When assembling a straight tube bundle, the two tube sheets and baffle assembly must be carefully and properly aligned and provisions made to hold all parts at the proper dimensions. This is often done by assembling the bundle within its own shell when the stationary sheet can be bolted to the shell flange and the floating tube sheet bolted to or held in place by a test flange, thus maintaining the original dimensions.

When attempting to retube a bundle outside the shell, it is necessary to line up properly the stationary tube sheet and baffle assembly on a channel frame. This tube sheet must be securely clamped to the channel frame.

Insert all tubes through the baffles and stationary tube sheet with the tubes extending beyond the face of the tube sheet, then line up the floating tube sheet and clamp it in place, maintaining exactly the same overall dimensions that existed before the tube next was dismantled. All tubes can now be moved into the holes of the floating head and properly spaced.

Peg all tube ends with a drift pin in the stationary tube sheet to prevent movement or revolving of the tube when using the roller expander. Several of the tubes around the periphery of the tube sheets should now be roller expanded lightly in both tube sheets to serve as anchoring stays. A group of tubes near the center of the tube sheets should then be expanded lightly at both ends.

Another check should be made on the accuracy of the overall dimensions from face to face of tube sheets. When these dimensions are correct, all of the tubes already lightly expanded should now be securely expanded. This will definitely fix the overall length and proper alignment of the tube bundle.

All tubes at one end should be expanded by the step forward rolling operation and at the opposite end by the step back rolling operation previously described.

Considering tube sheet warpage:

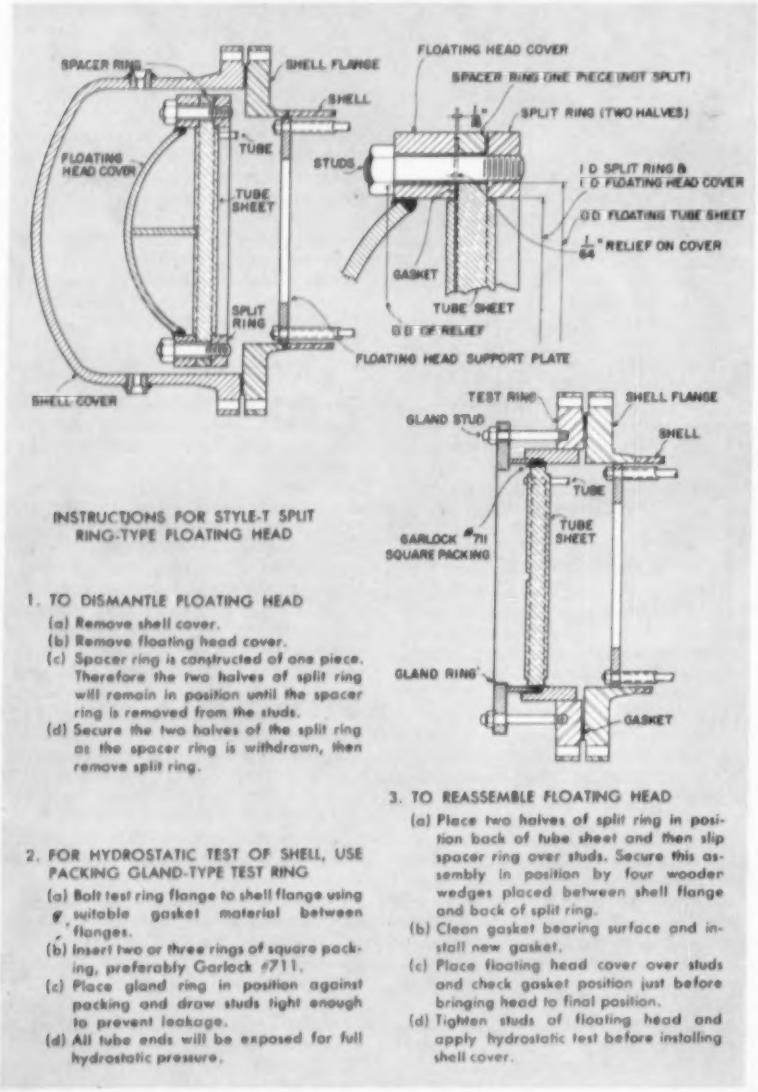

SPACER RING
SHELL FLANGE
SHELL
TUBE
FLOATING HEAD COVER
TUBE SHEET
SPLIT RING
SHELL COVER
FLOATING HEAD COVER
SPACER RING ONE PIECE (NOT SPLIT)
SPLIT RING (TWO HALVES)
STUDS
I D SPLIT RING & I D FLOATING HEAD COVER
O D FLOATING TUBE SHEET
1/64" RELIEF ON COVER
GASKET
TUBE SHEET
O D OF RELIEF
FLOATING HEAD SUPPORT PLATE
TEST RING
SHELL FLANGE
GLAND STUD
SHELL
TUBE
TUBE SHEET
GARLOCK #711 SQUARE PACKING
GLAND RING
GASKET
INSTRUCTIONS FOR STYLE-T SPLIT RING-TYPE FLOATING HEAD
1. TO DISMANTLE FLOATING HEAD
(a) Remove shell cover.
(b) Remove floating head cover.
(c) Spacer ring is constructed of one piece. Therefore the two halves of split ring will remain in position until the spacer ring is removed from the studs.
(d) Secure the two halves of the split ring as the spacer ring is withdrawn, then remove split ring.
2. FOR HYDROSTATIC TEST OF SHELL, USE PACKING GLAND-TYPE TEST RING
(a) Bolt test ring flange to shell flange using suitable gasket material between flanges.
(b) Insert two or three rings of square packing, preferably Garlock #711.
(c) Place gland ring in position against packing and draw studs tight enough to prevent leakage.
(d) All tube ends will be exposed for full hydrostatic pressure.
3. TO REASSEMBLE FLOATING HEAD
(a) Place two halves of split ring in position back of tube sheet and then slip spacer ring over studs. Secure this assembly in position by four wooden wedges placed between shell flange and back of split ring.
(b) Clean gasket bearing surface and install new gasket.
(c) Place floating head cover over studs and check gasket position just before bringing head to final position.
(d) Tighten studs of floating head and apply hydrostatic test before installing shell cover.

Fig. 9. In applying hydrostatic pressure to test for tube joints, follow these steps

Warpage of tube sheets can develop easily due to over-rolling of the tube ends or by rolling harder at one edge of the tube sheet than at the opposite edge. It is possible to keep the tube sheets perfectly flat if the mechanic fully understands the use of the expander equipment. The rolling operation should be performed by first expanding a few tubes around the outer periphery and near the center of the tube sheet.

It is then desirable to work from the center outward until all tubes are expanded. By use of a straight edge, the flatness of the tube sheet can easily be checked as the rolling progresses. If the tube sheet has a tendency to bow inward (i. e., toward the shell), it would indicate that the inner portion of the tube sheet has been over-rolled.

This could best be corrected by re-rolling the extreme outer ends of the tubes to stretch the metal further on the outside of the tube sheet, to bring the tube sheet back into parallel. It would be desirable to start at the middle of the bundle where the bow of the tube sheet was most severe and work outward, checking frequently with a straight edge.

Bowing of Tubes

Bowing of tubes during a retubing job, as explained earlier, is the result of the roller expanders causing the tube metal to flow inward, thereby causing the tubes to bow between the two tube sheets, to compensate for the slightly increased tube length. This bowing of tubes during a retubing procedure can be avoided if the mechanic fully understands and carries out the step back rolling procedure as outlined above.

Hydrostatic Tests

In order to test for tube joints, hydrostatic pressure should be applied. The proper test pressure should be determined by information on the name plate on the unit to be tested.

For U-tube heat exchangers, remove the cover plate from the channel head to expose all tube ends. Blank off all shell and drain connections, then fill shell completely full of water, venting the air from a connection in the top of the shell or in the top shell connections. Apply pressure either from the water main, or, if necessary, by a hydraulic hand pump.

For straight tube exchangers or heaters having style-T floating head, see Fig. 9 for complete description of head with instructions for dismantling and for proper use of a packed gland type of test ring, so that both ends of straight tubes can be exposed while applying test pressure to the shell side. When proper test pressure is reached, blow all moisture from the tube ends with a high pressure air hose, then look carefully for leaks.

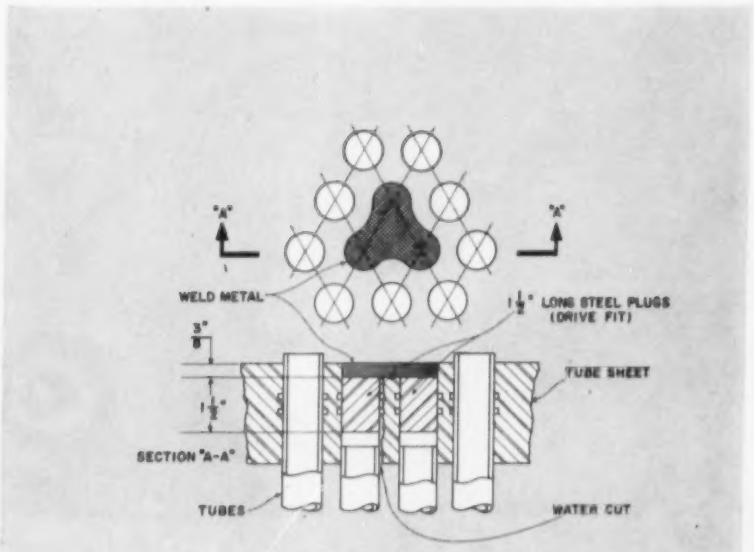
If water from the shell appears between the tube wall and tube sheet, then re-rolling of the tube end may stop the leakage. If water comes from inside of the tube, then the tube wall has failed and the tube may either be completely replaced or the tube holes properly plugged.

Plugging Tube Sheet Holes

In many cases it is impossible to replace tubes after failure has occurred. This may be due to a deformation of the tube wall from high internal pressure at the time of failure or by twisting of the metal at the point of failure at the time the tube ends are drilled out. This change in the shape of the tube wall will not allow the tubes to pass through the close clearance holes of the baffles or tube sheets. Heavy dirt deposits on the outside of the tube surface will also prevent complete removal of defective tubes.

When the tubes cannot be removed from the unit, then the tube hole must be properly plugged. When space is available through a short distance beyond the tube sheet, then the tube hole can easily be plugged by using a dummy tube. Close one end of a tube 8 in. to 10 in. long by welding, then insert this stub tube in the tube hole and properly roll it into the tube sheet.

When leakage between a tube wall and tube sheet has developed to such an extent that the tube sheet material has been badly eroded, then the tube hole must be permanently plugged by welding. See Fig. 10 for full information on this type of repair.



1. Water cut through tube sheet along tube wall may affect two or more tubes, so impossible to make tight by re-rolling.
2. Drill tube metal from tube sheet, using drill same OD as tube. If straight tube unit, drill 2 in. deep one end. At opposite end drill to within ½-in. of back side of tube sheet so tube will then be free to take care of expansion. If U-tube heater, drill 2 in. deep at both ends of element.
3. Fabricate 1½-in. long steel plugs with slight taper for drive fit in tube hole. Then drive until top of plug is 3/8-in. below top surface of tube sheet.
4. Cut away all ligaments between all tube holes affected by leak. This metal to be cut flush with tops of steel plugs.
5. Weld to tops of steel plugs and ligaments, gradually building up to surface of tube sheet. Carefully examine beads of weld, and peen between layers. Do not burn deep into solid ligaments next to sound tubes.
6. Follow same procedure at both ends of tubes even if tube sheet is not cut at opposite end of tubes.
7. After completing welds, apply hydrostatic test on shell side using full permissible test pressure. Allow this test to remain on unit from 12-24 hours.

Fig. 10. Method of repair for tube sheets of high pressure units where metal cuts away between two or more of the tubes. Here welding must be used to plug hole

WOULD YOU LIKE TEAR SHEETS?

If you want a copy of this special report by Ray Clapper on the maintenance of tubular heat exchangers, write The Editors, Power Engineering, 110 S. Dearborn St., Chicago 3. Or simply jot Heat Exchanger Tubing on the postcard inserted in this issue, and mail.

Fig. 1. The coal storage pile at large utility plant. Last year the electric utility power plants of the U. S burned a total of 160,000,000 tons of coal

Is It Right to Burn Coal?

TWENTY-ONE thousand tons of coal is a lot of coal; it fills some 340 railroad cars. Yet this is merely one day's supply for the Gary plant of the U.S. Steel Corporation. Every single day of the year this one plant uses 21,000 tons of coal, a total of 7,750,000 tons annually.

Fortunately, this coal is not burned, at least not in the sense that coal is burned in the furnaces of our power plants. While coal serves partially as a source of power in the steel industry it is far more valuable as a basic raw material, not only for the production of steel, but for countless other products as well. As is well known, from coal we get such diverse things as nylon, dyes, perfumes and cosmetics, drugs, soaps, and fertilizers, indeed, the list is endless.

In the steel industry, the basic use for coal is in the production of coke, one of the ingredients used in the blast furnace as it converts iron ore to molten iron. But in the production of this coke, gases are driven off the coal and these gases are the source of these many different products.

2000 Chemicals

Dr. Joseph Wells, chief research engineer of coal chemicals at U.S. Steel's Research Center at Monroeville, says that about 2000 chemicals have been identified in the gases driven off as coal is transformed into coke in by-product coke ovens. Of these chemicals, only about 50 are now being recovered and used by industry to make the various products that have contributed so much to the comfort of modern living but the other 1900 or more hold even greater promise for the future.

A ton and a half of coal, slow baked in an oven at 2000 F, yields a ton of coke. Until the early 1900's that other half ton escaped up the chimney as black smoke and gas. It was at that time that steel engineers and chemists began to realize that these gases were immensely valuable resources, and thus began the gradual conversion of the old beehive ovens into the modern by-product coke ovens.

1162 Ovens

The U.S. Steel Corp. pioneered by installing the first of these ovens in 1908. Today, at the Gary plant alone there are 16 batteries of these coke ovens with from 70 to 77 ovens in each battery, a total of 1162 in all. The coal bakes at temperatures of from 1800 to 2200 F for about 17 hours to form coke.

At Gary, after the baking is complete, the red hot coke is pushed into special railroad cars and these are then run into a quenching tower where cold water is poured onto the hot coke. Steam billows out of the tower as 3000 gal of water are evaporated in less than two minutes. The coke is then sent to the blast furnaces for use in making steel.

While the coke is extremely necessary in steel production, it is the gas which is driven off which is of intriguing interest because this is where all the exotic chemicals come into the picture. This gas passes off into a collecting main at 750 C, and is immediately sprayed with water to bring the temperature down to 80 C. The whole gas then goes to the chemical recovery plant, a huge conglomeration of pipes, towers, valves and pumps.

A view of the new chemical recovery plant at the Gary works is shown in Fig. 2. In this series of distillation towers, the chemicals are distilled from light oils taken from the gases produced in the coke ovens. In the center of this plant, in the brick building seen in the photograph, is the air conditioned and sound proof control room. The control is completely automatic but by means of an elaborate diagram on the control board the operators know at all times what is taking place in the system.

The control room is shown in Fig. 3 though this view shows only about two thirds of the board as a whole. Of interest are the miniature recording and indicating instruments mounted on the panels. These provide a complete record of all the operations. Signal lamps flash in case of trouble and at any time the operators can shift from automatic to manual control.

Coal Chemistry

The chemical process involved is extremely interesting. After the gas from the ovens is cooled, by means of precipitation, the first ingredient is condensed — a thick, black liquid called tar. At Gary, the tar is used to produce naphthalene. Meanwhile, the gas, minus the tar, is carried to the saturator. There it passes through diluted sulfuric acid where crystals of ammonium sulfate precipitate from the solution. What is left of the gas goes through a benzene scrubber where absorption oil is sprayed through the gas.

The absorption oil is merely distilled tar, which is also a product of the gas. Next, the light oils are separated from the absorption oil. The light oil is distilled, and at about 80 C the benzene boils and passes off

as a vapor. At about 110 C, the toluene passes off as a vapor, and at a temperature of about 135, the xylene passes off.

As a further step, the crude fractions called solvent naphthas are collected. The gas, now cleared of many of its chemicals, is used as fuel gas in firing the huge open hearth furnaces which keep steel rolling for this — the world's largest integrated steel mill.

The chemicals are shipped by tank car to manufacturers who transform them into nearly everything imaginable. For example, from the benzene comes Styrene (synthetic rubber plastics), phenol (adhesives and plastics), aniline (dye intermediates), nylon, insecticides. From the toluene comes paint, lacquer, varnish solvents, aviation gasoline additives, polyurethane resins (aircraft insulation), saccharine, vanillan, TNT, and other explosives.

From the solvent naphthas come resins for asphalt tile, linoleum, other floor coverings, and plastics. From the nitrogen products comes ammonium sulfate — a high nitrogen fertilizer for lawns and field crops. From the naphthalene come phthalic anhydrides for plastics, appliances and auto finishes. And so on, the list is endless. And, it all comes from ordinary black coal — the same coal we burn by the hundreds of millions of tons under boilers where the only thing we get out of it is a little heat — some 12,000 Btu per lb.

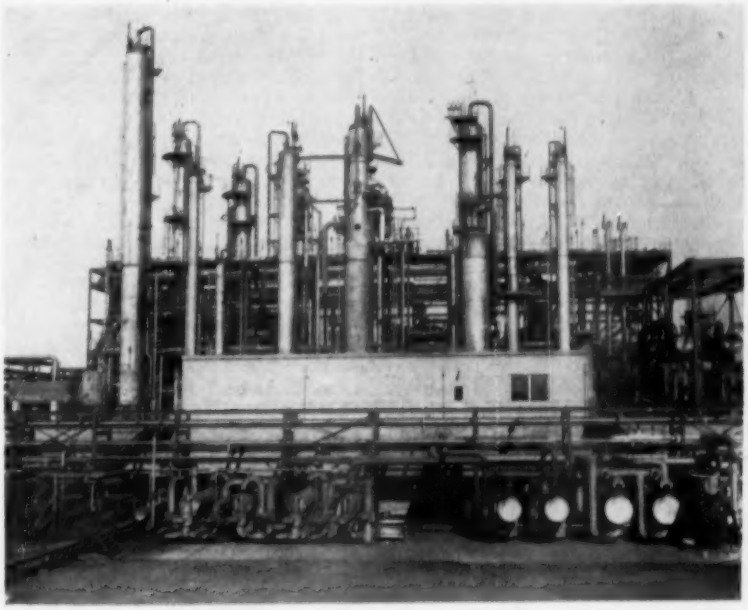
Economics

There is considerable discussion these days concerning the economics of nuclear power; whether or not nuclear power is, or is not competitive with power from coal or other fossil fuels. At the present time, it is not, because coal is still relatively cheap in most of the U. S.; but if coal is considered, not as a mere fuel, but as one of the most versatile and valuable raw materials in the world, then, if we take our future well-being into account, coal becomes a very expensive fuel.

No doubt, the time will come when the need for the by-products of coal become so great that we will no longer be permitted to burn coal under boilers. When one stops to consider that each ton of coal will yield on the average 145 lb of chemicals in addition to ¾ ton of coke and a sizable amount of gas fuel, it becomes possible to estimate how much material wealth is being wasted in the coal-burning furnaces of our power plants.

Last year the electric utility plants of this country burned 160,000,000 tons of coal. Of course, all coal is not suitable for coking but assuming that this coal could have been coked, it would have produced 11,600,000 tons of chemicals, a vast quantity of gas fuel, and over a hundred million tons of coke. The Btu value of coke is only slightly less than that of the coal from which it is made so the coke and the gas fuel could still have produced a vast amount of electrical energy.

The recovery of chemical from coal, of course, is a question of economics. Technically, the processes have been known for many years. Indeed, it is just 100 years ago, this year, that a young chemistry student in England, William Henry Perkin discovered the synthetic dye called mauvine. Perkin's discovery was the great landmark in the history of chemistry; it led quickly to an appreciation of the latent chemical possibilities in coal tar. The forerunners of modern coke ovens which could be sealed to insure complete recovery of gases were used in Germany and France as early as 1860. A battery of 12 ovens was installed in America in 1893 in Syracuse, N. Y., to recover ammonia. United States Steel recognized the value of the process in producing coke for its blast furnaces and so brought Heinrich Koppers from Germany in 1906 to supervise the construction of a coke plant at Joliet, Ill. This was the first successful coke and chemical recovery plant built in America.



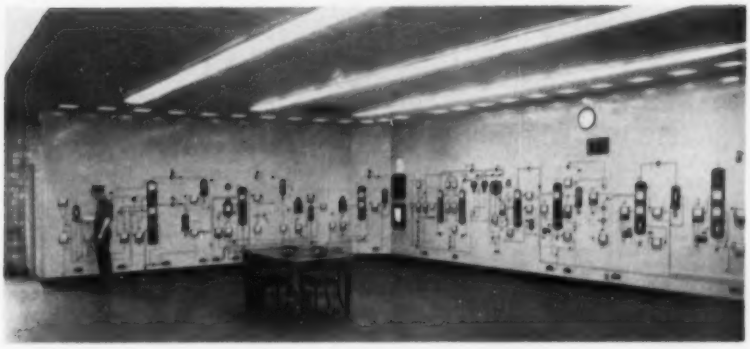


Fig. 2. (Above) This maze of pipes, tubes, tanks and valves makes up the new chemical recovery plant at Gary Steel Works. In this series of distillation towers, chemicals are distilled from light oils taken from the gas produced during the manufacture of coke

Fig. 3. (Left) In the center of the chemical recovery plant is this air-conditioned, soundproof control room from which the entire chemical recovery process is controlled automatically

What About Spare B-F Pumps?

How much spare boiler feed pump capacity would you have to figure on for these two situations: (1) where the b-f pump is driven by main turbine generator; (2) where a once-through boiler is used?

By IGOR J. KARASSIK*

THERE ARE TWO special cases which must be examined in detail in connection with the decision to be made as to spare boiler feed pump equipment. These are installations where the boiler feed pump or pumps will be driven from an extension of the main turbine generator, and installations with a once-through boiler.

In the first case, regardless of the number of boiler feed pumps used to serve the unit, some sort of a start-up pump will be required. Generally, the main turbines can be started up as soon as a reasonable steam pressure is available at the boiler. For instance, a 200,000-kw main unit designed for 2400 psi throttle pressure would only require 100,000 lb per hr of steam at 600 psi before it can be rolled over. Therefore, leaving out the question of spare capacity, a start-up pump for say 125,000 lb per hr and some 700 psi discharge pressure is all that is necessary.

Obviously, if a true spare pump, capable of operating either independently or in parallel with one of the boiler feed pumps driven from the main generator, were to be installed, it would have to be designed for full boiler pressure. But even here, the spare boiler feed pump need not necessarily be capable of developing exactly the same pressure as the main feed pumps, as can be seen from Fig. 1.

For instance, if a full-capacity main feed pump is serving our unit, the spare pump can be designed for either half-capacity or even one-third capacity. In such a case, the total head the spare pump must be capable of developing need only be the system-head at the reduced capacity selected. There is considerable advantage to be gained from this approach, since a lower head pump and a smaller driver will obviously be less expensive than a unit designed for the same pressure as the main feed pump.

The decision on whether to use strictly a "start-up" pump or to install a spare pump which can also carry a partial load, will be affected to a great extent by the desired method of operation following an electrical trip-out of the main unit. Because of the sudden reduction in steam demand, the pressure in the boiler drum will rise abruptly. The bubbles in the water-and-steam mixture at the water surface of the drum will collapse and the visible level will plunge below the gage glass. At this moment, the question is whether the interruption is to be strictly momentary. In other words, will the disturbance which tripped out the generator be cleared in a matter of minutes and will the unit return to normal operation? Or will it be shut down and temporarily secured?

If the unit is to be shut down, we need not concern ourselves with feeding the boiler at this moment. The furnace has a tremendous rate of heat release when fired, but as soon as firing is interrupted, the modern high pressure boiler starts cooling down without the need of further feeding, because it has a relatively low heat retention.

Therefore, a unit which will be operated in this fashion need not necessarily be provided with an independently driven spare pump capable of developing full boiler pressure plus friction losses merely to protect the boiler. The only advantage of a full pressure spare pump (regardless of its rated capacity) is that it can substitute for the main pump or pumps in case of emergency, so that the turbine generator can stay on the line, carrying load.

On the other hand, if it is intended that an electrical trip-out interrupt operation only temporarily, the situation changes. Neither the boiler nor the steam turbine should be permitted to cool down to such an extent that immediate return to service would become hazardous. As a matter of fact, with proper precautions, a momentary electrical trip-out will not shut down the main turbine but only reduce generator load to the auxiliary power demand.

But it certainly would be impossible to maintain the boiler at temperature if firing were completely discontinued. And yet, can the boiler be safely fired — even on a reduced scale — if the water is completely out of the gage glass? How do we know where the level is?

It would appear, therefore, that we must continue to feed the boiler (even if it were at some much reduced rate) in order to re-establish the water level to where we can see it. Thus, a full pressure start-up and spare pump, independently driven, is indicated in this particular case. If this pump is intended strictly to re-establish water level in the gage glass, it can be made a plunger-type reciprocating pump, designed for a very nominal capacity, such as 25,000 or 50,000 lb per hr.

In this case, the start-up pump must be of a different sort than in the situation which we have just examined. At this writing, it is expected that prior to starting up the main unit, a flow of from 30 to 40 per cent of the rated throttle flow must be circulated through the once-through boiler at full pressure before the main unit can be started up.

If the boiler is served by half-capacity pumps or a full-capacity pump driven independently by an electric motor, the pre-start circulation can of course be provided by the main boiler feeding equipment. If the

* Assistant to vice-president, and consulting engineer, Harrison Division, Worthington Corp.

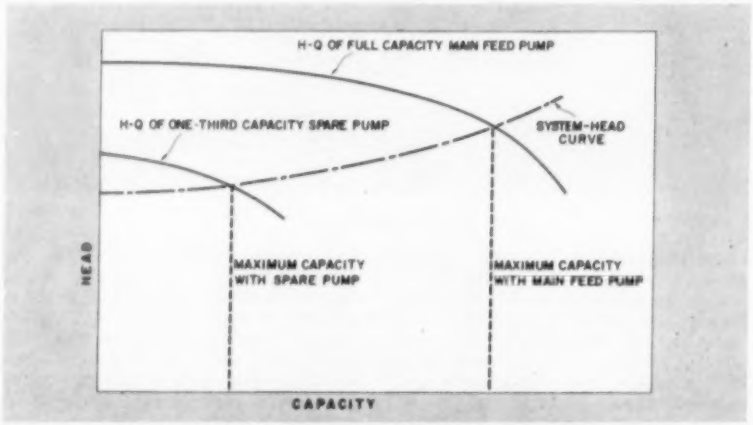

H-Q OF FULL CAPACITY MAIN FEED PUMP
H-Q OF ONE-THIRD CAPACITY SPARE PUMP
SYSTEM-HEAD CURVE
MAXIMUM CAPACITY WITH SPARE PUMP
MAXIMUM CAPACITY WITH MAIN FEED PUMP
HEAD
CAPACITY

Fig. 1. Even with main turbine drive, the spare boiler feed pump need not necessarily be capable of developing exactly the same pressure as the main feed pumps

boiler feed pumps are either steam turbine driven or driven from an extension of the main unit, an independent motor driven start-up pump must be provided.

On the other hand, here again the choice of the capacity and pressure rating of the start-up pump is flexible. Again referring to Fig. 1, the requirements as to capacity and pressure can be reduced to those at the desired intersection with the system-head curve. And while the savings may be limited in the case of subcritical pressure units served by half-capacity pumps, there is a distinct possibility for major savings in the case of supercritical units served by full-capacity pumps.

To use but one example, let us consider a 300,000-kw unit operating at 3500 psi throttle pressure. Let us assume that the discharge pressure at rated flow is 4500 psi, in other words that 1000 psi friction loss exists at full load. Two half-capacity pumps of 1,000,000 lb per hr each will be provided and driven either by steam turbines or from the main generator. We shall further assume that these pumps handle 300 F feedwater and take their suction at 200 psig. Each pump, then, will handle 2170 gpm and develop a net pressure of 4300 psi or a total head of 10,800 ft. Their approximate power consumption will be 7060 bhp.

If the start-up pump were designed for 40 per cent flow, the required discharge pressure on the system-head curve would be reduced from 4500 psig to approximately 3750 psig (including control valve losses). Thus the pump could be rated at 1750 gpm and a net pressure of 3550 psi or a total head of only 8920 ft. The power consumption would be reduced to 4700 bhp. Thus, the required motor size would be reduced from 7500 to 5000 hp.

A further saving can possibly be realized if the supercritical once-through boiler and main turbine are permitted to operate at subcritical pressures at light loads. If, for instance, the throttle pressure at start-up is reduced to 2500 psi, a still lower discharge pressure will be required from the independently driven start-up pump and a still lower hp rating from its driver.

It must be fully understood, of course, that these considerations are based strictly on the lack of desire to compensate for any unscheduled interruption of service from the main feed pumps. If half-capacity feed pumps are involved, the penalty for interrupted or reduced capability may indicate that the increase in investment, which is the difference in installed cost between a duplicate start-up and spare pump and a pump of somewhat reduced capacity and pressure rating, is fully justifiable since the former provides true stand-by service.

If spare pumps are included in an installation, we must have a clear conception of their function if we are to utilize them advantageously. A distinction must be made as to this function since a spare boiler feed pump may either (1) be used strictly on standby service, so that it is operated only during emergency shutdowns or at the time of a scheduled inspection and overhaul of the normally operated equipment; or (2) operate in regular rotation with the other boiler feed pump or pumps, so that equal operating hours accumulate for all the pumps installed in the station.

The choice between these two operating methods is, to a certain extent, controversial in that it reflects almost entirely the personal preferences of the operators. On the other hand, this choice plays a major part in the arrangement of the spare pump and, in some cases, even in its selection.

To illustrate this statement, consider the case of a power plant provided with motor-driven half-capacity pumps arranged for variable speed operation by means of hydraulic couplings.

If the spare pump is to be rotated, it is necessary to install three exactly duplicate pump sets, each with a hydraulic coupling (as in Arrangement B, Fig. 2).

If, on the other hand, the spare pump is to be used strictly on stand-by service, the hydraulic coupling may be eliminated (as in Arrangement C, Fig. 2) and its function replaced by an individual feedwater regulating valve. This valve is located between the spare pump discharge and the common header. It permits the spare pump to operate at constant speed and still parallel the variable speed pumps at all flows. This solution has the added advantage of preserving duplication between the pump rotors since the reduction in total head resulting from the slip in the hydraulic coupling driven units is matched by the reduction in pressure through the feedwater regulating valve.

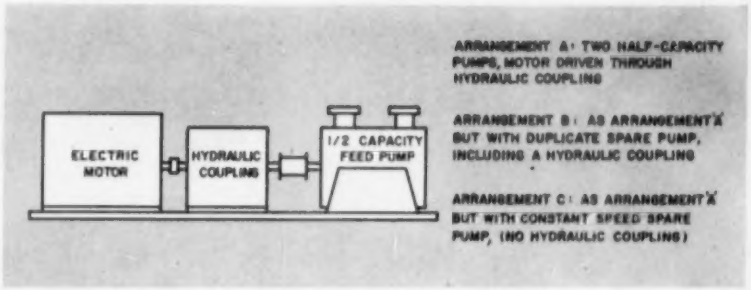

ELECTRIC MOTOR
HYDRAULIC COUPLING
1/2 CAPACITY FEED PUMP
ARRANGEMENT A: TWO HALF-CAPACITY PUMPS, MOTOR DRIVEN THROUGH HYDRAULIC COUPLING
ARRANGEMENT B: AS ARRANGEMENT 'A' BUT WITH DUPLICATE SPARE PUMP, INCLUDING A HYDRAULIC COUPLING
ARRANGEMENT C: AS ARRANGEMENT 'A' BUT WITH CONSTANT SPEED SPARE PUMP, (NO HYDRAULIC COUPLING)

Fig. 2. Arrangements for a power plant provided with motor-driven half-capacity pumps arranged for variable speed operation by means of hydraulic couplings

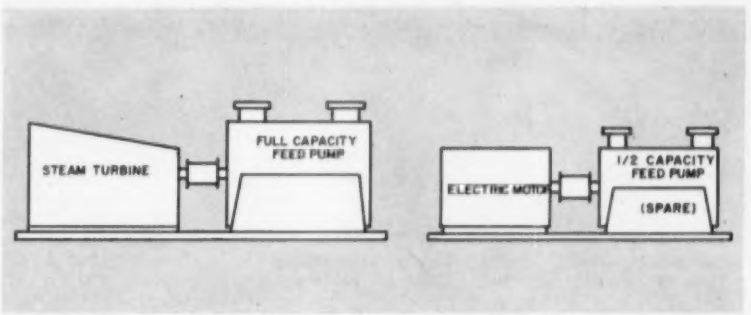


Fig. 3. In some cases, it may be desirable to reduce the investment in spare equipment by using a half-capacity motor-driven spare pump, as shown here

Another interesting example is that of the installation of a full-capacity, turbine-driven boiler feed pump. In some cases, it may be desirable to reduce the investment in spare equipment by using a half-capacity motor-driven spare pump (Fig. 3) rather than a duplicate full-capacity pump. It is rather obvious that this arrangement precludes the "rotation" function except possibly in terms of operation of the motor-driven pump at light loads. Even this limited use of the spare pump will depend on the relative economy of operation for the two pumps.

There is also a distinction to be made with respect to the method of starting a spare boiler feed pump, since it can be made to start automatically on loss of header pressure or started manually at the choice of the operator. These two starting methods have a definite bearing on the arrangement of the standby equipment and we shall discuss this in a subsequent article. We shall also discuss the problems introduced by the use of a common spare boiler feed pump for two adjacent units.

The APPR

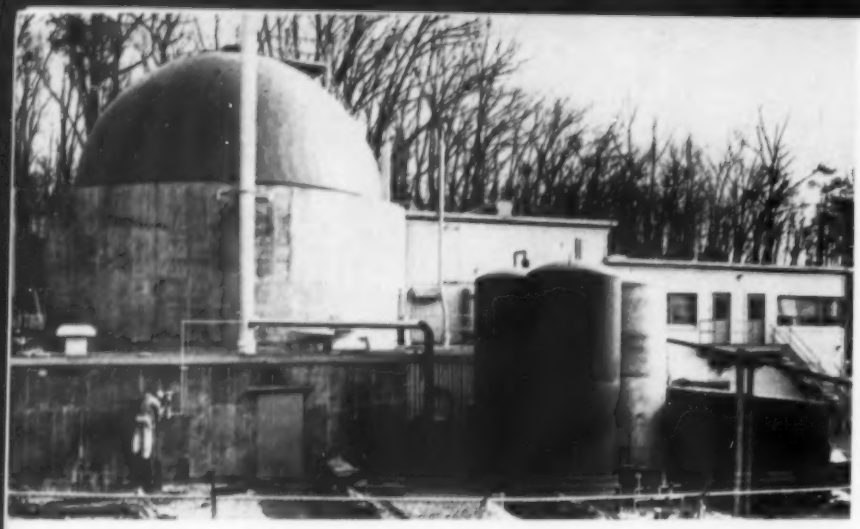


Fig. 1. General view of the Army Package Power Reactor at Fort Belvoir, Va. This shows the vapor container at the left. In addition to two feet of concrete on the inside the steel shell is surrounded by three feet of concrete on the outside from ground level to the height of the control room forming a biological shield

THE ARMY Package Power Reactor at Fort Belvoir, Va., generated electricity for the first time early in April; it sustained a chain nuclear reaction at 6:20 a.m. on Monday, April 8, 1957. The operation of this nuclear power plant will be of great interest to utility and industrial power engineers alike because this plant is of a size that would make it applicable for the production of power in industrial plants.

APPR, as it is called, is a 2035-kw pressurized-water nuclear electric generating plant built by ALCO Products, Inc, under contract to the U. S. Atomic Energy Commission for the U. S. Army — it is the Army's first nuclear power plant. This plant is the first prototype of a family of nuclear power plants under development by the Atomic Energy Commission and the Department of Defense for use by the three military services. The concept envisions that the components will be transportable by air and capable of erection at a remote field site in a six-month construction period. Because of these features it has been called the Army Package Power Reactor.

While the requirements called for a *package* power plant, it was necessary to modify the design of the Ft. Belvoir installation to provide a greater measure of safety than that needed at a remote site. Even with the inherently stable characteristics of the pressurized-water reactor, the project's location, only 18 miles from Washington, D. C., required that special emphasis be given to containment of radioactivity. A vapor container had to be designed that would be capable of withstanding the maximum credible accident, even though such accident is highly improbable.

General Design

The APPR plant comprises two systems — a primary system consisting of the reactor vessel and core, control rods and drives, two coolant circulating pumps, piping, steam generator, pressurizer, water purification equipment and shielding, and a secondary system comprising the secondary side of the steam generator, the turbine-generator set, surface condenser and auxiliaries, feedwater heater, evaporator, pumps and storage tanks.

The secondary system is essentially the same as the steam turbine end of a conventional power plant. The principal difference from a conventional power plant lies in the primary system, where a nuclear reaction replaces conventional fuels as a means of heating the water.

The reactor core forms the heart of the system. Housed in the core are 38 fuel elements containing fully enriched uranium, together with 7 control rods — all in a grid structure of a basic 7 by 7 design with the corners missing.

Cooling water enters the reactor vessel at 431 F under pressure of 1200 psi to prevent boiling. While circulating upward between the fuel plates at 4000 gpm, it is heated to 450 F and then passes on to the steam generator. In the steam generator, heat from the high-pressure water is transferred to the water in the secondary system, thus producing the steam used to drive the turbine.

The cycle is completed by using special Westinghouse *canned-rotor* pumps to return the condensate from the condenser to the reactor. The two pumps are constructed primarily of stainless steel and are similar to the pumps used in the submarine Nautilus.

The steam generator produces 34,700 lb of steam per hour at 200 psi and at 407 F. A superheater is provided which raises the temperature to 432 F. This superheater is contained inside the same shell with the steam generating section but separated from the latter by a baffle.

As shown by the diagram, Fig. 2, the reactor, pressurizer, the steam generator and the primary pump, are all contained in the vapor container. This is a steel vessel fabricated by Bethlehem Steel and consists of a center cylindrical section with top and bottom hemispherical sections.

The steel shell is lined with two feet of concrete. An additional three feet of concrete surrounds the container from ground level to the height of the control room. This concrete provides a biological shield as an extra measure of protection in the immediate area. The purpose of the vapor container is to confine radioactive particles and gases in the event of a nuclear accident.

The vapor container has two manholes, both open inward to assure tightness under internal pressure. The top manhole, at the very top of the container, is 6 ft, 7-in. in diam-

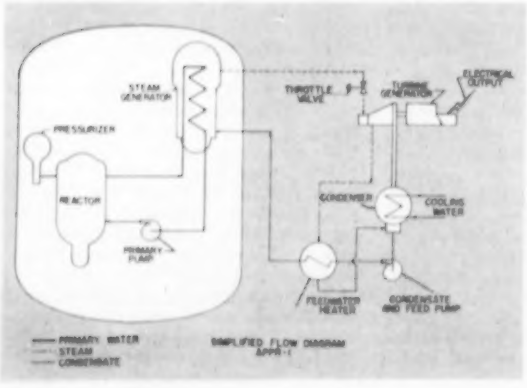


Fig. 2. Simplified flow diagram showing the primary and secondary systems. The primary system is enclosed in the vapor container

Begins Operation at Fort Belvoir

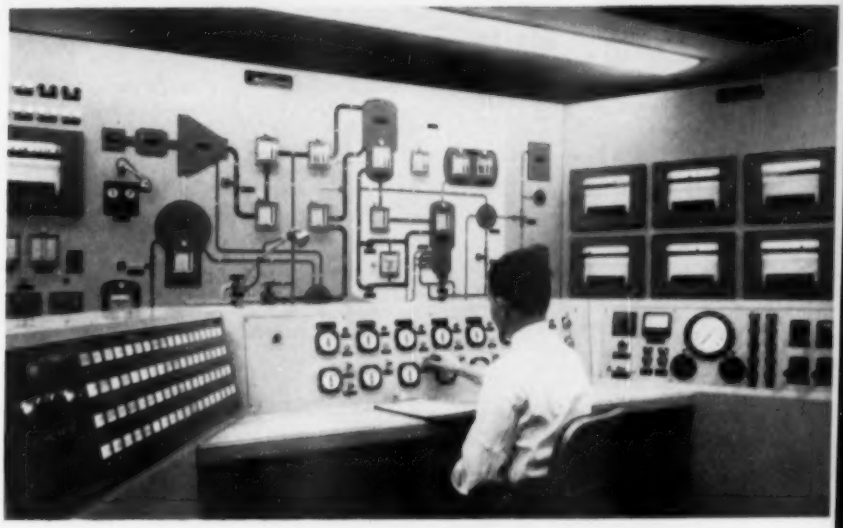


Fig. 3. A view in the control room. The instrumentation system consists of four units: a console at which the operator sits, a colorgraphic panel directly in front of him, and two panels holding full-size indicators and recorders. All of the system piping, pumps, valves, heat exchangers, etc are clearly shown

eter and was used to install equipment initially. The lower manhole is a short tunnel, 9 ft long with a door at each end. It is 4 ft, 6 in. in diameter and penetrates the concrete secondary shield.

The lower manhole is filled with water, which together with the steel in the manhole covers, provides a biological shield equivalent to 5 ft of concrete; it is equipped with a low level alarm. A general view of the entire plant is shown in Fig. 1.

Details Of The Primary System

As already mentioned, the reactor core consists of 38 fuel rods and 7 control rod assemblies fabricated by the Oak Ridge National Laboratory. The arrangement is shown in Fig. 4. The core and its supporting structure are housed in the stainless steel-clad reactor vessel built by ALCO. This is 47½ in. in diameter and 162 in. overall in length and is clad with 0.125 in. stainless steel on all surfaces in contact with primary water.

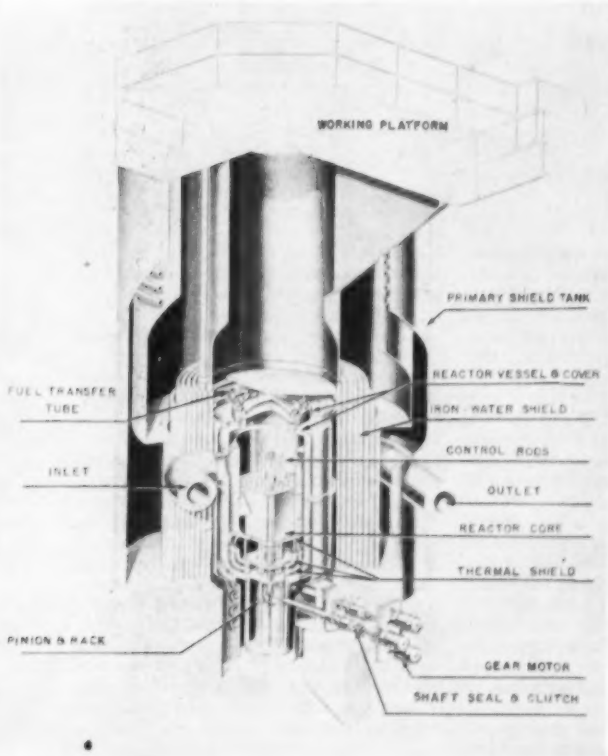


Fig. 4. Isometric drawing of the reactor vessel, core and control rod structure in the APPR. This illustration shows five control rods but the actual APPR core contains two additional safety rods normally in the fully withdrawn position

The fully enriched, uranium-dioxide fuel is incorporated into flat-plate type elements. Each fuel assembly consists of 18 fuel plates brazed into a pair of 304L stainless steel side plates 27 in. long, 2.863 in. wide and 0.050 in. thick. The two outside plates are 27 in. long, and the 16 inner plates 23 in. long.

Each assembly has on both ends a 304L stainless steel grid adapter, or end box, attached by fusion welding. The control rods consist of two sections: a fuel section, and an absorber section. The absorber section is boron enriched in the isotope boron-10.

The use of stainless steel in the construction of the fuel elements is interesting because the APPR is the first power reactor to use such material with light water as the coolant and moderator. It was chosen because of its excellent corrosion resistance in pressurized water. It seems likely that the stainless steel APPR fuel elements will not only advance the technology of pressurized water reactors but it may be a major factor in economical power production in remote locations.

Another interesting feature of the fuel elements is the use of boron carbide as a burnable poison. This involves a relatively new idea in reactor operation and was also used in the design of the new Engineering Test Reactor at Arco, Idaho. The use of elemental boron reduces the range of reactivity to be controlled by mechanical means. The neutron-absorption cross section of the poison (boron) is such that it burns out at nearly the correct rate to compensate for the burn-up of the uranium.

The boron is incorporated directly into the uranimum during fabrication of the fuel plates. The fuel core of the composite plate is prepared by

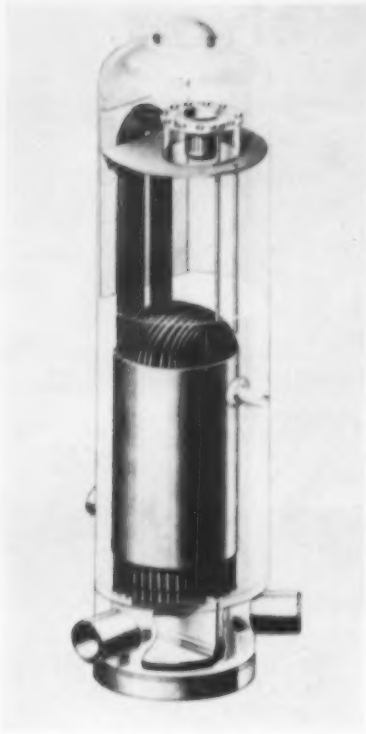


Fig. 5. A phantom view of the steam generator. This drawing shows the steam generator portion at the bottom and the superheater section at the left

adding 28.62 gm of UO_2, 0.188 gm of B_4C and 99.80 gm of stainless steel powders. These elements are placed in a glass container, and a number of these containers are placed together in an oblique blender.

After blending, the mixture is poured into a die and pressed under 33 tons psi to form the fuel core for the composite plate. When a number of cores have been so prepared, a batch is sintered in a hydrogen atmosphere at 2150 F. Thereafter, each core is again placed in the die and coined in final size.

The advantages of preparing the fuel plates individually in this way, against the possibly more economical batch blending, are accurate accounting of the uranium and boron, and excellent homogeneity. Once formed, the coined fuel cores are placed in blanked frame plates; covers are attached to each side of the frame, and the plates fabricated into composite fuel plates. They are preheated in a hydrogen muffle at 2100 F and rolled to a 91 per cent reduction in thickness. During rolling the stainless steel cladding is metallurgically bonded to the stainless steel core material. Eighteen of these plates form one fuel element.

The steam generator has a U-shaped tube bundle with 326 tubes each ¾ in. OD by 0.062 in. wall, with a total effective heating surface of 836 sq ft. Inside the same shell but separated from the generating section is the superheater section with 194 sq ft of heating surface. Hence, the total heating surface is 1030 sq ft.

The 1200 psi operating pressure of the primary system is maintained by two immersion heaters housed in a stainless steel pressurizer built by ALCO. The pressurizer, which is 45 in. in diameter, mounted on a cylinder 16 in. in diameter by 54 in. long, contains sufficient steam and liquid to absorb fluctions of primary liquid volume without excessive pressure changes.

Water in the primary system is thoroughly purified to protect against corrosion. This system contains about 1300 gal of water which is circulated at a rate of about 4000 gpm. This water is maintained at a total solid concentration of not more than 2 ppm. Portions of the water in the primary loop are removed and purified in two demineralizers furnished by General Ionics Corp.

As a contamination safeguard, the resin and the demineralizer unit containing it will be periodically removed and discarded. When the water leaves the demineralizer it contains no more than 0.5 ppm of total solids. After passing through the micro-metallic filter, it enters a 5000 gal stainless steel tank for recirculation to the primary loop.

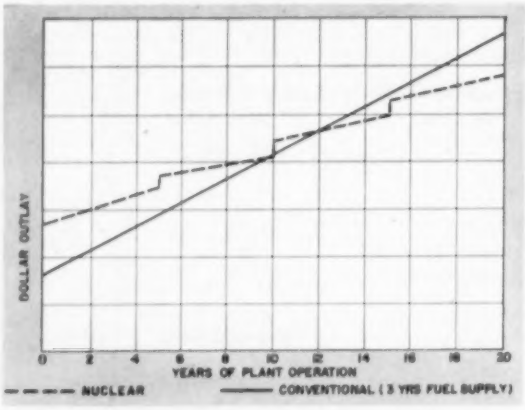


Fig. 6. Comparative cumulative outlay for nuclear and conventional plants. Curve shows that a nuclear plant gives increasing savings after 12 years of operation

Shielding

The primary shield is a 156-in. diameter steel tank filled with water and containing 9 concentric steel cylinders. The arrangement is shown in Fig. 4. Each cylinder is 2 in. thick and the cylinders are separated by an inch-thick layer of water. The innermost cylinder also serves as the inner wall of the tank and as a support for the pressure vessel. An iron-water shield was selected because it weighs less, is smaller than an equivalent concrete shield, and permits faster fabrication on the site.

The secondary shield — 5 ft of concrete — was designed so that the dose rate will be less than 1.5 mr per hr at any point outside the vapor container.

Details Of The Secondary System

The turbine-generator is a 2500-kw General Electric turbine driving the generator through a reduction gear at a speed of 1200 rpm. It delivers 60-cycle current at 4160 volts. Excitation is from a 15-kw direct connected exciter.

The condenser is a Lummus two-pass, divided water box, single tube-sheet surface condenser with the tubes sealed to the tube sheet with 50/50 solder and then rolled into serrated tube-sheet holes. Serration provides exceptional joint strength as well as a labyrinth seal between tubes and tube sheet to prevent leakage of circulating water into the secondary system.

The feedwater heater, located between the condensate and feed pump and the steam generator, receives steam from a bleed point in the turbine. A Hagen 3-element regulating valve is provided in the feedwater connection to the steam generator. Close regulation of conditions in the steam generator and the secondary system in general is maintained by adjusting the blowdown.

The strong negative temperature coefficient of the APPR makes it a very stable system and the Minneapolis-Honeywell instrumentation and controls were designed to take full advantage of this stability. With a temperature coefficient of at least -2×10^{-4} per degree F, no additional control mechanism is needed to override rapid transients or power excursions.

What this means is, that the reactivity will adjust itself automatically to the demand for steam, or to the demand for electricity. If the electrical load should suddenly decrease there would be less need for steam and the temperature of the steam and water in the reactor would tend to increase.

This increase in temperature would

tend to decrease the density of the water and steam in the reactor (the mean free path of the atoms would increase), and as a consequence, their effect as a moderator would tend to decrease; hence the reactivity of the reactor would decrease. This would result in a decrease in the rate at which steam was produced, and thus, the reactor would tend to *follow* the electrical load. And, in fact, this is exactly what it does.

In one instance, during the preliminary tests on the APPR, when carrying the full electrical load of some 2000 kw, the load was suddenly dropped to that represented by only the station auxiliaries — a matter of about 200 kw. Despite this sudden drop in load, the reactor responded almost instantly; it adjusted the rate of steam production to the new electrical requirements without readjustment of the control rods, merely by virtue of the self regulating characteristics of the reactor.

This, it will be obvious, is quite unlike the performance of a conventional fuel-fired plant, where when the load on the turbine drops, it is necessary immediately to cut the fuel feed to the furnace as well as the air supply by means of manual or automatic combustion controls.

The control room of the APPR is a beautiful job. It is attractively designed and despite the multiplicity of instruments on the panels and the console, the system is simple and effective. As shown in Fig. 3 it consists essentially of four parts. On the panels at the right are the recorders for monitoring and recording the neutron flux. These include both linear and logarithmic recorders.

In the center is the panel showing the primary and secondary systems. This, as will be noted, is in diagram form with miniature recording instruments at the proper places in the system. All piping, pumps, valves, heat exchangers, tanks, and other parts are clearly depicted. At the extreme right, not seen in the photograph, is the electrical instrument and control panel. This differs in no way from the electrical control panels in an ordinary power station. On the console, in the center of the room are mounted the controls and indicators for the control rods, and also a very elaborate annunciator system for monitoring the operation of equipment throughout the plant.

Startup of the APPR is manually controlled in coordination with indications from electronic pulse counting channels. Two instrument channels monitor the neutron flux from the source level to an intermediate range of power to insure safety in startup. Detectors in these channels are the boron-trifluoride and fission chamber types. Compensated ionization chambers serve as the detecting elements for neutron flux covering power levels from the intermediate range to 150 per cent of rated plant power.

Three identical ion-chamber channels are provided in the safety circuit. These have the main function of *scramming* the reactor if the power should reach unsafe levels. Scramming is accomplished by release clutches holding the control rods out of the reactor core during operation. These clutches are released electronically, and very rapidly, in response to high neutron flux level, and the rods drop by gravity, thereby inserting the boron poison that shuts down the reactor. Two of the three safety channels must agree that scramming is required to preclude a *scram-happy* condition of operation. This is called a coincident circuit.

A final period channel is provided to prevent dangerous runaways. This channel, instead of merely responding to the absolute power level or neutron flux, responds to the rate of increase of power level and scrams the reactor when that rate reaches abnormally high values.

Each unit in the control system was built and thoroughly tested at Minneapolis-Honeywell's Panel Division in Philadelphia. M-H engineers worked closely with Stone & Webster personnel to produce units that would fit into the allotted space, and with ALCO engineers to plan a complete and convenient operating system. Furthermore, a small group of Army Signal Corps personnel were trained by Minneapolis-Honeywell in nuclear instrument maintenance.

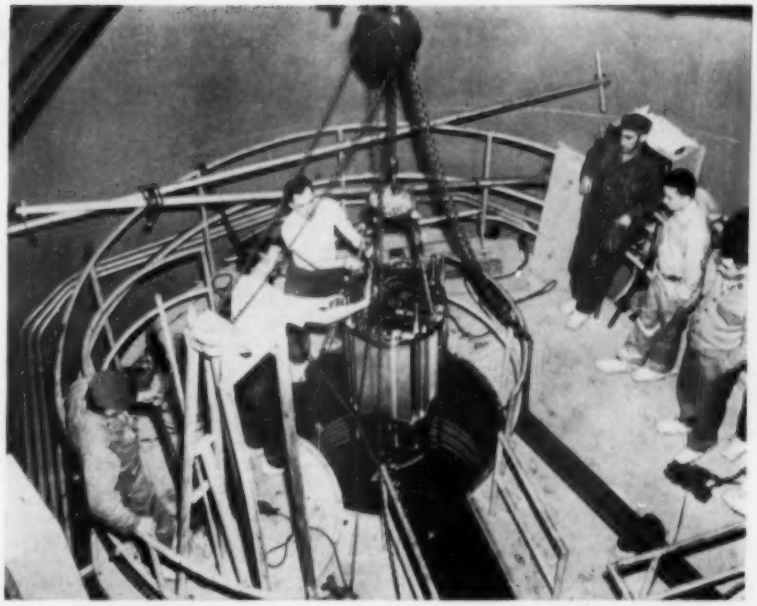


Fig. 7. Technicians set core structure of the APPR in place. This core, which is about the size of a barrel, will operate the APPR at full power for a year and a half

Operating Personnel

Operation of the Army Package Power Reactor requires a staff of 29 specially qualified personnel. The initial crew is made up of ALCO engineers and Army, Navy, and Air Force officers and enlisted men. Crew members engaged in almost a year of intensive training and preparation leading up to the successful operation of this plant.

The APPR is designed to be operated by technicians with a basic high-school education. Key supervisors are engineers with a college degree. The basic operating shift has five men; an engineer as shift supervisor and four technicians in the positions of control room operator, plant equipment operator, instrument man and maintenance man.

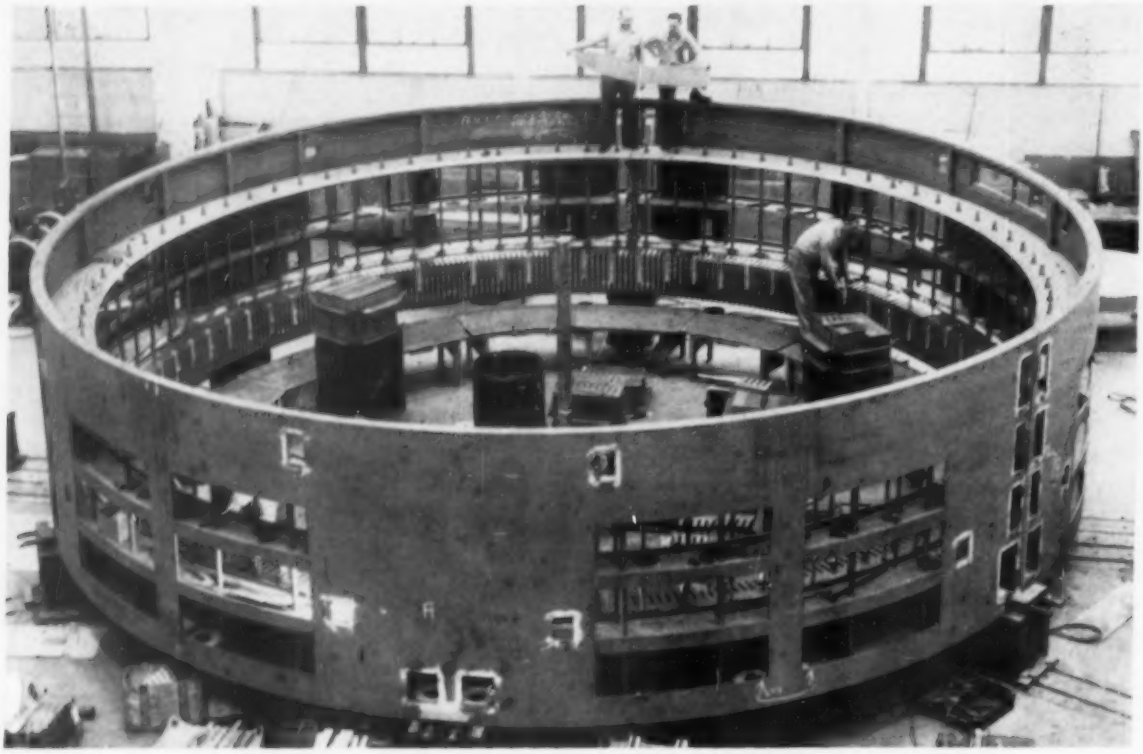
During the initial 700-hour continuous operation test each shift is being augmented with two additional engineers: one a control room supervisor and one to perform chemistry and supervise water treatment. In addition a group of professional men and technicians is available for round-the-clock surveillance of health physics.

A reactor scientist was in charge of initial reactor loading and startup. Experienced power plant engineers supervised startup of the conventional power machinery. Plant management includes an operating superintendent and a superintendent of physical plant. An electrical engineer is in charge of maintenance of plant instrumentation and controls.

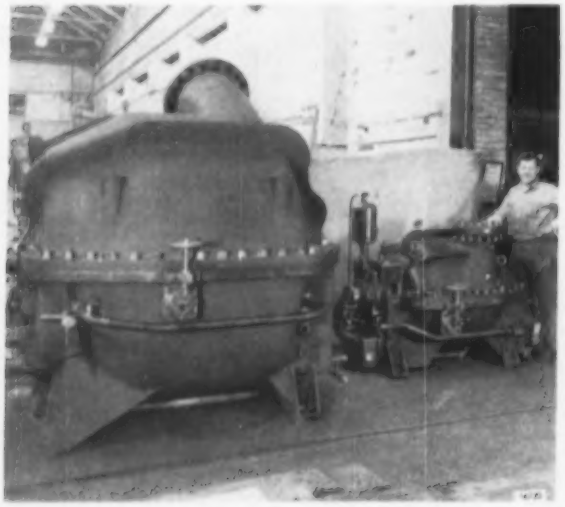
Economy

The military advantages of nuclear power are derived primarily from logistic considerations. Since nuclear power plants can be built to operate over extended periods without refueling, the great military advantage of such power plants is the elimination of all but a small fraction of the logistic effort which otherwise would be required *continued on page 112*

POWER ENGINEERING'S NEWS REEL



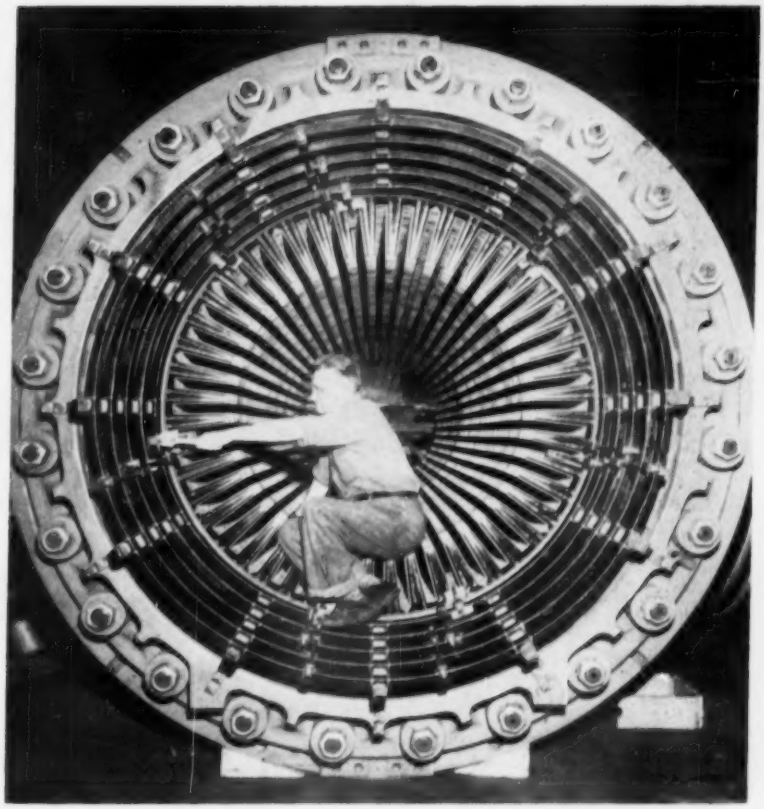
Hydroelectric Generator Stator, rated at 64,000 kw, is ninth such unit being built by Westinghouse for Chief Joseph Dam in state of Washington. Nearly 35 ft in diameter and weighing about 305,000 lb, stator is stationary part of vertical waterwheel generator that will generate electric power from the Columbia River. The nine hydroelectric generators thus far built for the Chief Joseph Dam have capacity to supply power for city of more than 1,000,000



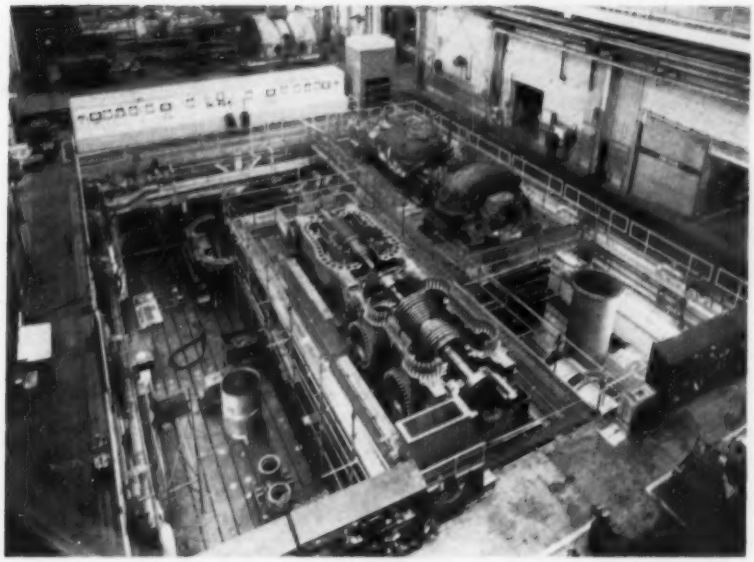
It Isn't Always Size That Counts; smaller of two refrigerating compressors, right, has 2250-ton capacity, big unit, 1500 tons. Four of York 2250-ton units will cool shopping center, enough capacity for 4500 6-rm houses

Giant Wire Rope Sling made by American Chain & Cable is clue to growth in size and weight of industrial equipment. Made from 3-in. wire rope, breaking strength of sling is rated 720,000 lb; safe load, 144,000 lb

Symmetry in Steel is formed by this inner core of 156,250-kw generator stator being built by General Electric Company's Large Steam Turbine-Generator Department Plant ⟶



Research "Machine" Guns below are more machine than gun. Developed by Lockheed Aircraft, these tools enable scientists and engineers to learn how to shape metals with explosive charges acting in die molds



Hugh Test Pit for Big Turbines goes into service at Allis-Chalmers plant. Photo shows assembly of first 300-mw unit for Detroit Edison Co; high and intermediate pressure elements in center foreground. Part of Oak Creek No. 4 under test in background. Test pit is equipped with all necessary auxiliaries

Working Model of Belgian Thermal Reactor, being built by Westinghouse to supply 11,500 kw, is made from 512 colored plastic parts, shows operation

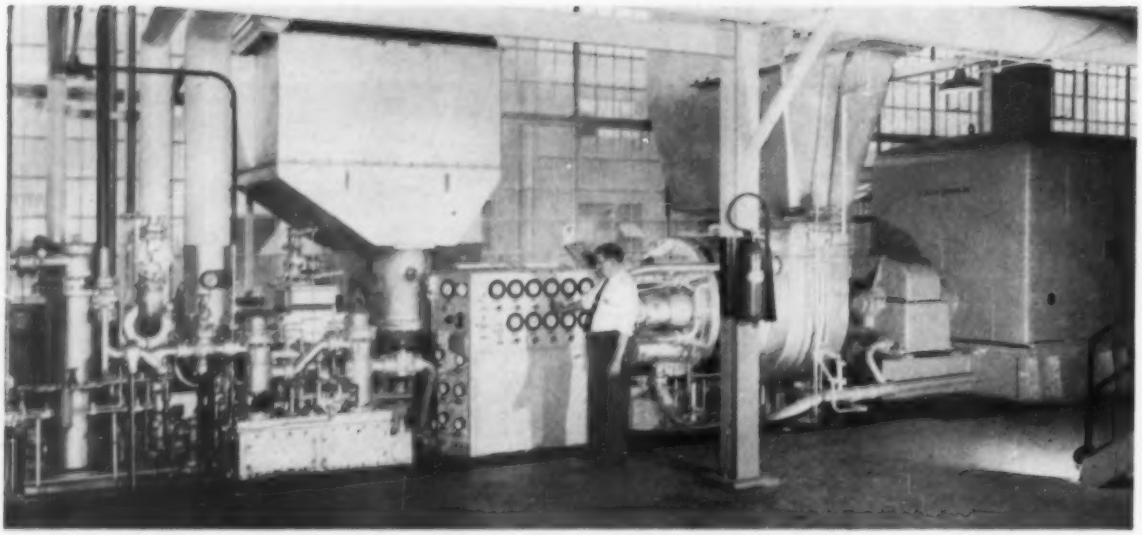


Fig. 1. Installation of a simple-cycle gas turbine in plant of Gates Rubber Company to generate power and supply highly preheated combustion air for a steam boiler. Generator is at right in photo, gas turbine in center, intake duct, left

Here's How To Use Exhaust Heat

How much usable heat can you expect from a gas turbine? How can you use it? Here are some answers from an expert in this field

DURING THE EARLY years of gas turbine development, designers and operators of these units were concerned almost entirely with improving the cycle efficiency of the machines themselves. A great deal of engineering time, brains, and ingenuity went into refinements that would extract a few per cent more shaft energy from the amount of fuel energy consumed.

In recent years, however, it has come to be generally realized that the gas turbine, in addition to producing power at the shaft, also puts out recoverable energy in the form of compressed air and hot exhaust gas which retains a major part of its oxygen. These "by-products" of shaft power sometimes prove to be useful dividends that may be put to work to increase the efficiency of a plant-wide operation.

By thus shifting emphasis on gas turbines from the idea that they are just another form of prime mover, competing with other prime movers, to the concept that gas turbines are dual-purpose machines, producing power *plus* recoverable heat energy, entirely new fields of usefulness are opened. Viewed in the latter context, the gas turbine can become a very efficient machine indeed.

In a paper* presented to the American Power Conference, March 1957, W. B. Wilson of General Electric Co gave an instructive example of a gas turbine installation at a plant of Gates Rubber Co.

In this plant, the gas turbine with its supplementary-fired exhaust-heat-recovery boiler is supplying approximately 5000 kw of electric power and 120,000 lb per hr of steam for power or process use. It supplements the output of power and process steam from an existing steam turbine power plant.

Basically, the turbine and boiler components are arranged as shown in Fig. 2. This provides flexibility in plant operation because the boiler is arranged for operation at any pressure desired between the 200 to 300 psig process level and 450 psig, the initial pressure of the existing steam turbine power plant. Operating at 450 psig, this boiler can supply or augment the supply of steam to the steam turbines when required, such as when one of the regular fuel-fired boilers is out of service for inspection.

Gas turbine-generator installed at the Gates plant is shown in Fig. 1.

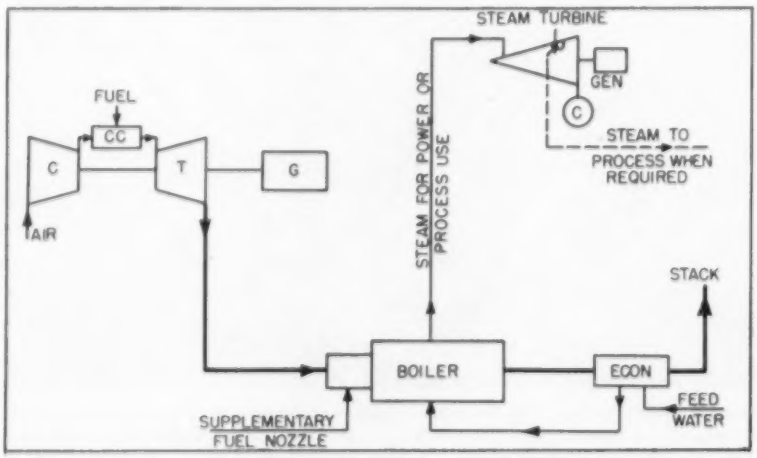


Fig. 2. The gas turbine with supplementary-fired exhaust-heat-recovery boiler

*"Industrial Application for Combined Gas Turbine-Steam Turbine Plants," by W. B. Wilson, General Electric Co.

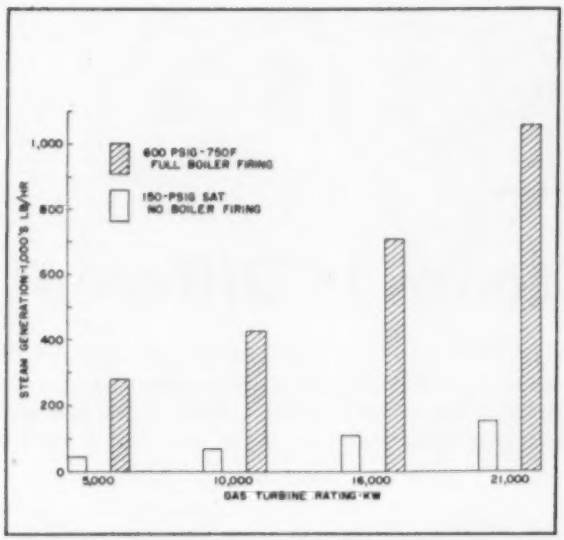


Fig. 3. Steam generation with gas turbines exhausting to exhaust heat and fuel-fired exhaust-heat-recovery boilers

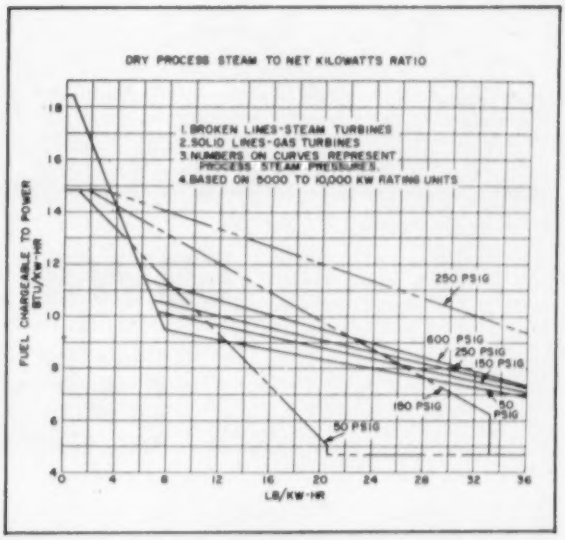


Fig. 4. Fuel chargeable to power if process steam is used; gas turbines vs 600 psig, 750 F extraction steam turbines

From a Gas Turbine

This gas turbine† will normally operate with natural gas fuel, but it is designed to operate on natural gas, oil, or a combination of both. Air enters the compressor through the duct at left and the turbine exhausts to the boiler through duct at right.

Supplementary fuel-fired exhaust-heat-recovery boiler is located just outside the turbine room. It also is arranged for gas or oil firing.

Based on this plant's requirement for 5000 kw, plus 120,000 lb per hr of 250 psig steam, fuel chargeable to power with a gas turbine would be approximately 30 per cent less than for a 600-psig, 750-F steam turbine plant. Performance of the steam turbine plant would be improved by use of higher initial steam conditions. Even so, when the requirement is for 450-psig steam, fuel chargeable to power with a 1250-psig steam turbine plant will still be higher than for the gas turbine. A requirement for high pressure steam is a condition favorable to the gas turbine.

Use of gas turbines to supply highly preheated combustion air for fuel-fired boilers is an excellent application and a few brief comments on some of the components of such a plant should help orient our thinking.

Except in areas of very low fuel cost, industrials usually expect at least two useful outputs, power and heat, from the gas turbine. A third useful output, oxygen in the hot exhaust gas, is also being utilized at the Gates Rubber Company's plant.

The gas turbine most often used for application in industrial plants is the simple-cycle, single-shaft unit. It consists of a compressor, a combustion system and a turbine. Air flow is almost five times that actually required for combustion of fuel burned in the turbine. This leaves much unused oxygen in the turbine exhaust that can be utilized for the combustion of additional fuel. This excess air is necessary to maintain turbine inlet temperature within limits and, of course, to add mass flow required to power the turbine. Exhaust temperature ranges up to 800 or 900 F.

The gas turbine can then supply at least four useful outputs:

1. Shaft power—for generator or mechanical drive.
2. Heat—recovered from the exhaust for various uses.
3. Highly preheated combustion air.
4. Compressed air.

continued on page 112

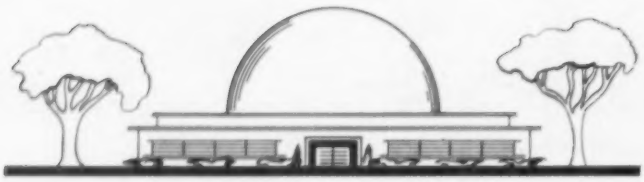
† Brown, R. J. and Smith, A. N., "5000-Kw Dual-Fuel Gas Turbine for Industrial Power", 1956 Fall Meeting of ASME, Denver, Colorado.

Table shows fuel needs, steam output with gas turbine exhaust-heat-recovery and fuel-fired exhaust-heat-recovery boilers

Gas Turbine Rating		Air Flow lb/hr	Permissible Total Fuel[1]	Approx. Fuel[2] to Gas Tb.	Permissible Fuel[1] to Boiler	Heat[3] From Fuel Added in Steam	Approximate Boiler Performance			
							No Boiler Firing		With Full Boiler Firing	
kw	hp						Btu Added in Steam[3]	Equiv. 150 Psig Saturated Steam lb/hr	Btu Added in Steam[3]	Equiv. 600 Psig-750 F Steam lb/hr
5,000	7,000	355,000	418	100	318	286	40	40,000	326	274,000
10,000	14,000	567,000	667	170	497	447	62	62,000	509	426,000
16,500	22,500	928,000	1092	273	819	737	104	103,000	841	706,000
21,800	30,400	1,370,000	1613	387	1226	1102	150	149,000	1252	1,050,000

(1) Million Btu/hr higher heating value natural gas based on total gas turbine compressor air flow and allowing 15% excess air. (850 lb air/million Btu)
(2) Million Btu/hr HHV Natural Gas
(3) Million Btu/hr based on 400 F stack

NOTES: DATA BASED ON
(a) GE simple-cycle, single-shaft gas turbines operating at rated conditions.
(b) No allowance for boiler radiation or blowdown.
(c) Feedwater at 220 F.



EBWR Steam Is Different

Steam from boiling nuclear reactor is different not only because of its radioactive characteristics but also because it contains free hydrogen and oxygen which make it more corrosive. Rigid purity requirements of both steam and water introduce many problems in design

IN A POWER PLANT using nuclear fuel the reactor serves the same purpose as the boiler in a standard steam power station using conventional fuels. This is a very apt comparison in the case of the new Experimental Boiling Water Reactor (EBWR) at Argonne National Laboratory, because in this plant the reactor is actually the boiler. Nuclear energy liberated by a chain reaction heats the uranium fuel plates which form the core of the reactor. The heat is transferred to the water that comes in contact with the fuel plates. The water boils and part of it is converted into steam which, at the proper pressure, is usable for generating electricity.

In other types of power reactors, a fluid, such as a gas, liquid metal, organic compound, or water under very high pressure, is used to remove the heat from the reactor *without* boiling. The hot fluid is then used to generate steam in a heat exchanger.

The direct steam cycle of the EBWR eliminates the need for the intermediate heat exchanger and permits operation of the reactor at a pressure which is no higher than that required for the turbine generator.

A flow diagram of the EBWR system is shown in Fig. 1. Except for the substitution of the reactor for the conventional fuel-fired boiler, the steam-water circuit is similar to that of a conventional steam plant. After passing through the turbine, the steam is condensed in a water-cooled condenser, and the condensate is returned to the reactor. In construction, however, in the choice of materials, and in the design of equipment, the EBWR system is very different.

The water, for example, has to be far purer than the water in even our modern high-pressure steam stations. Furthermore, since the steam becomes slightly radioactive, it was necessary to develop a leak-proof power cycle to prevent radioactive steam from escaping through the shaft seals of the turbine and other parts of the system. Steam leakage from the glands of a conventional steam cycle turbine of this type exceeds 1000 lb per day.

In the EBWR system, steam leakage is designed to be less than one pound per day out of the system, and water leakage into the system from ambient air less than one-half pound per day. Such low leakage rates have never been attained in ordinary steam plants but never before has such an incentive existed to reduce leakage rates.

At present, when EBWR is being operated with light water, this highly effective leakproof system is of value only in reducing the radioactive hazard, but later, when the reactor will be operated with heavy water, this remarkable reduction in leakage will result in substantial savings in operating costs — even with heavy water at the extremely low price of $27 a pound.

Another difference between the EBWR and a conventional steam system is the far greater care taken to provide materials that would resist corrosion. The turbine, for example, is nickel plated internally to avoid corrosion.

The properties of the steam generated in a nuclear reactor differ from those of ordinary steam in two respects which affect power plant design. Reactor steam is slightly more corrosive because small amounts of water are dissociated into hydrogen

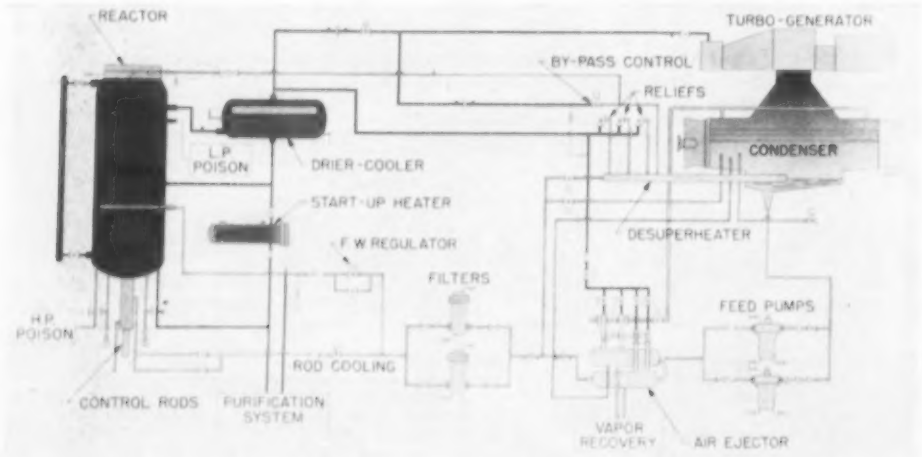


Fig. 1. EBWR Flow Diagram. This system is noteworthy because steam from the reactor passes directly to the turbine without intermediate heat exchangers. Note external steam drier in main steam line and filters in the condensate return line

and oxygen and these free elements make the water more corrosive. The corrosion and erosion particles become radioactive as they pass through the reactor core and some of the particles inevitably will be carried over with the steam.

When the idea of the production of steam directly in a reactor was first proposed there was apprehension concerning the radioactivity of the steam but this aspect of direct-cycle boiling reactors seems to have caused undue concern. Almost all of the radioactivity in the coolant of a water-moderated reactor is due to the short-lived oxygen decay. There are two principal activities in oxygen under the influence of neutron bombardment. These are:

$$O^{18} + n_{\text{thermal}} \rightarrow O^{19} \text{ (29 sec)} \rightarrow F^{19} + \beta + \gamma \text{ (1.6 Mev)}$$

and $O^{16} + n_{\text{fast}} \rightarrow N^{16} + p$

N^{16} (7 sec) $\rightarrow O^{16} + \beta + \gamma$ (6 Mev)

The second reaction predominates, but neither reaction is very probable, so that the actual activity encountered in pure cooling water in a reactor is never very high; rarely over 1000 times normal human tolerance. The difficulty is that the gamma radiation in the N^{16} decay is extremely hard (highly penetrating), so that large thicknesses of dense shielding are required around the reactor vessel to reduce the radioactivity to a tolerable level. Fortunately, this does not hold for the parts of the system external to the reactor.

The velocity of the steam is many times higher than the velocity of water entrained in the steam, since its density is much lower. Thus the amount of coolant contained in the pipes external to the reactor is much lower when the coolant is in the form of steam than when it is in the form of water. Indeed, in the actual operation of EBWR the radioactivity of the steam is much less than had been expected. The radioactivity in the steam leaving the reactor is 5000 times less than in the water in the core.

The steam rises from the water surrounding the core to a steam collection ring at the top of the reactor vessel at a rate of about 0.4 ft per sec. In doing so most of the entrained water falls back into the vessel. For all practical purposes, because of the short-lived nature of the radioactivity in the water, there should be very little radioactivity in the steam external to the core, assuming that the water remains pure. Despite all precautions however, it will be virtually impossible to keep the water free from impurities.

As already indicated, the water will be slightly more corrosive because of the dissociation of a small portion of the water into oxygen and hydrogen, and even though corrosion resistant materials are used throughout the system, it is inevitable that some corrosion, or erosion, particles will appear. If such corrosion particles pass through the reactor they will become highly radioactive and will be entrained in the minute droplets of water carried in the steam.

For this reason, a steam dryer-emergency cooler has been installed in the main steam system between the reactor pressure vessel and the turbine as shown in the diagram, Fig. 1. In addition to minimizing radioactive carryover, this vessel dries the steam leaving the reactor.

In addition to normal operation at 61,000 lb per hr at 600 psi, low pressure operation and transient conditions also had to be considered. In normal operation the steam leaving the reactor contains approximately 1 per cent moisture. With the dryer this is expected to be reduced to 0.1 per cent, and the solids in the steam, less than 0.001 ppm.

To achieve economy, it was decided to combine in the same steam separator vessel a stainless steel cooling coil for use in emergency heat absorption. After a reactor shutdown, for example, the decay of fission products will continue to generate a considerable amount of steam which normally would be condensed in the main turbine condenser. In an emergency the cooling coils will remove this heat. A 15,000 gal tank in the top of the building supplies a 50-ft head of cooling water which will flow by natural circulation to the cooling coils in the steam dryer.

The value of 0.001 ppm of solids in the steam of the EBWR compares with a maximum value of 1.0 ppm which is now standard practice for most large, high-pressure boilers, though most large units operate below this value. In conventional high pressure plants the reason for maintaining low total solids content in the steam is to keep the silica deposits in the turbine down to a minimum.

At the Argonne plant the reason for this extra care to keep solids low is to prevent not only silica particles but also corrosion particles from getting through to the turbine. If such radioactive material were deposited on the turbine blades it would make maintenance very difficult. The three main sources of impurities are, (1) system corrosion products; (2) inleakage of impure condenser cooling water, and (3) corrosion of fuel element material.

To reduce corrosion products special care was taken to select material which would become the least radioactive. In the condenser, for example, aluminum tubes were selected in preference to admiralty metal tubes because aluminum particles become the least radioactive in passing through the reactor.

To reduce the number of corrosion and erosion particles, extensive use was made of stainless steel. The reactor vessel is stainless steel clad and piping, valves and fittings of auxiliary systems are stainless steel.

With such stringent requirements regarding low solids content of the steam, it was almost imperative to install demineralizing equipment for the treatment of the feedwater since the purity of demineralized water is usually superior to distilled water. Triple distilled water in glass has a specific conductance of 1.0 micromhos whereas water produced by monobed demineralization will have a specific conductance of only 0.055 micromhos. One micromho of specific conductance will normally indicate a dissolved solids content of 0.5 to 0.6 ppm.

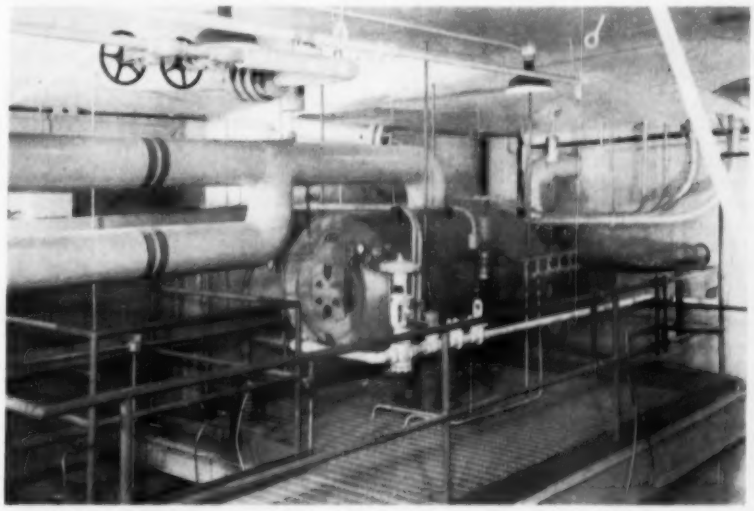


Fig. 2. Here is shown the drier-cooler which serves the dual purpose of stripping water from the steam and acting as a heat exchanger for emergency use in removing the accumulated heat stored in the reactor when it is suddenly shut down

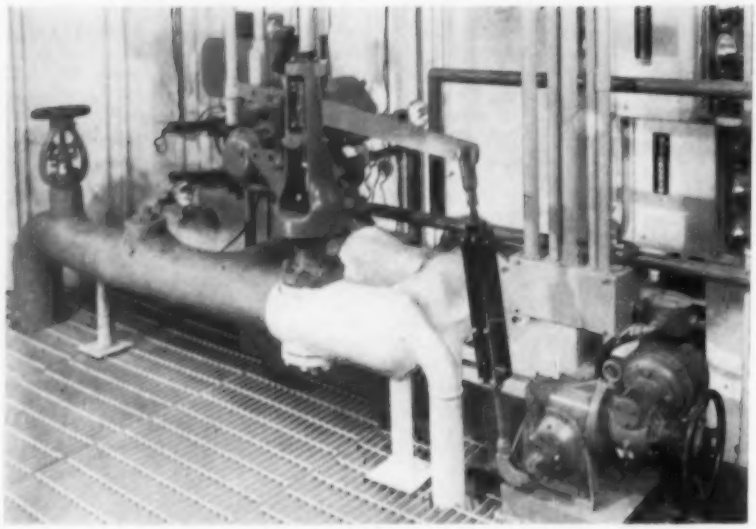


Fig. 3. This automatic valve regulates the flow of feedwater to the reactor

To produce water of the desired purity two separate Graver demineralizing systems were installed at the Argonne plant. Each system contains two rubber-lined, mixed bed demineralizers, together with accessories and instrumentation. These all-stainless steel systems remove water from the bottom of the reactor vessel through any of the four 6-in. recirculation lines and, after cooling, deliver it to the ion exchange columns. The purified water is pumped back into the reactor vessel with the feedwater.

Nuclear vs Conventional

The two pumps which continually recirculate the water through the purification system and the reactor are quite different from the ordinary type pumps. They are a special design of Allis-Chalmers Electri-Cand pumps, with fluid piston type thrust and radial bearings. With this bearing the liquid being pumped becomes the bearing lubricant and the shaft floats during running, resting on the bearings only when stopped. Rotor and stator windings are *canned* and the water being pumped flows through the space between the rotor and the stator.

Before the feedwater enters the reactor it passes through disposable cotton filters to remove any corrosion or erosion particles that may be present. Two parallel full-flow filters are provided; normally one is in service and the other on standby. Each filter has a capacity of 180 gpm and is capable of removing particulate matter down to 2 and 5 micron size. *Hot* filter cartridges are removed either to the cave building for cartridge replacement or, if need be, to the burial ground.

It should be evident from even this brief discussion of the steam and water system of the EBWR power plant that conditions in a nuclear plant are quite different, and require much closer attention than those in conventional power plants. The water and steam have to be of far higher purity; total solids have to be reduced to as close to zero as possible; leakage has to be maintained at a value far below anything conceivable in ordinary power plant practice, and, of course, because of these more stringent requirements, monitoring of all values has to be more exact.

In considering this difference between nuclear and non-nuclear plants, it should be noted that all of them are essentially non-nuclear in nature. As pointed out by Admiral Rickover recently, it is a common belief that atomic power development is primarily the province of the nuclear physicist. Nothing could be further from the truth.

Very few of the difficulties that have been experienced with nuclear power plants have involved the reactor. Experience with the four operating plants of the naval reactor program has shown that the heat exchangers, the pumps, valves, and the piping systems have proved less reliable than the reactor itself. Also, the cost of these components has been high and delivery poor.

Admiral Rickover says that it has been very difficult to get sufficient effort directed toward the more conventional aspects of nuclear plants — the heat exchangers, the pumps, the valves and fittings, and the instrumentation. Normal engineering and manufacturing techniques, Rickover claims, have proved inadequate when applied to nuclear power plants.

What actually faces the designer of nuclear power plants is how to determine, by calculation and by experiment, the best way to remove heat from a reactor and then to design and build all the components of the reactor system to operate safely and reliably under the most rigorous conditions.

The problems include the familiar ones of using materials at great temperatures and pressures. They also include the ability to withstand corrosion to a high degree. Some new problems raised by atomic power are caused by the fact that in nuclear fission heat is generated *inside* a fuel element and proceeds *outward*, whereas in the chemical combustion process the heat is applied from the outside and proceeds inward.

In chemical combustion we are normally limited to a maximum of about 3000 F, but in nuclear fission we can achieve temperatures of millions of degrees. Also with nuclear fission we can achieve rates of rise in power level of millions of kilowatts in fractions of a second. Moreover, we are faced with radioactivity and its tendency to distort and weaken materials. The fact that many materials capture neutrons and thus tend to stop the chain reaction severely restricts the nuclear plant designer in his choice.

Much more rigorous inspection of material and construction is necessary in the case of nuclear plants than in conventional plants because of the greater need for reliability. Failure of a component in a nuclear power plant is far more serious than in a conventional plant because of the radioactivity hazard and the resultant difficulty of access for maintenance and repair.

Specific Knowledge Needed

The nuclear designer needs much more specific knowledge concerning the properties of materials under various conditions. So far, as pointed out by Admiral Rickover, the metallurgical problems that have arisen in the development of nuclear power have had to be solved by empirical means since there is a scarcity of knowledge of fundamental principles involved. Thus, metallurgical advances have required the use of extensive manpower and expenditures of large sums of money. Until the fundamental processes involved are understood, additional large-scale use of manpower and money will be required to solve each slightly different problem as it arises.

The Argonne EBWR plant is, of course, a small plant as power plants go but its simplicity and successful initial operation reflect the skill and knowledge with which the designers have taken these many problems into account. Power generation itself is not a primary objective of this plant; it is purely an experimental plant built to supply further information needed in the design and construction of large commercial nuclear plants. Its operation as a complete integrated power system will throw more light on the uncertainties of radioactivity, corrosion, leakage, water quality control and many other questions.

Startup Purging of Steam Turbines

Timely discussion of evidence which suggests that purging of any turbine is highly desirable as early as possible in starting process

By C. W. BELL, Sr.

FOLLOWING discussion of the merits of early purging of steam turbines is presented as possible practice for all condensing units.

Frankly, the report of the Ridgeland turbine failure and subsequent discussions, as already published, prompted these comments. (See POWER ENGINEERING, December 1955 and October 1956, also ASME paper No. 55-A-172.)

It is not intended here to question the metallurgical concept of the basic cause of this failure. The isothermal pattern followed by the initial cracks has been recognized. However, this writer has seen many evidences of excess temperatures which developed in turbines during the starting process and believes more weight should be given to the effect of thermal stresses in the Ridgeland failure.

What seems more than possible is that there may be abnormal temperature zones within the turbine, during parts of the start-process, which do not appear on operating instruments.

This opinion is based on intimate knowledge of the starting behavior of many units operating at pressures up to 400 psig and certain 1250-psig, 950-F units.

The following comments outline certain indications that may be useful in analyzing a turbine's starting characteristics. Recommendations are made for accomplishing quick purging.

It is a common experience to find exhaust temperatures entirely out of line with indicated vacuum readings (high P.A.P.) in large as well as small condensing turbines, during starting and in some cases during the early stages of loading.

Numerous influences have a bearing on this; some are matters of design, some of relative maintenance, some of the technique of starting and loading.

Design Points

Design items include the following:

Effectiveness of turbine shaft seals under vacuum and at low speeds.

Protection against reverse flow in drain connections leading ultimately to open drain tanks such as condensate storage tanks.

Packing of valve stems normally subject to pressure, but under vacuum during starting, must be "two-way" packing.

Drip pumps which are subject to vacuum during starting must have suitable packing and sealing features.

Provision of a hogging jet, to assist in establishing good vacuum quickly, is important.

Maintenance of these items in top condition is as important as is the maintenance of parts directly affecting production.

The author has been associated with power plants for more than 50 years, at least half of them spent on major maintenance and general care of turbines of many types and sizes, including large machines operating at 1250 psig, 950 F. Mr. Bell is now a consultant in this field

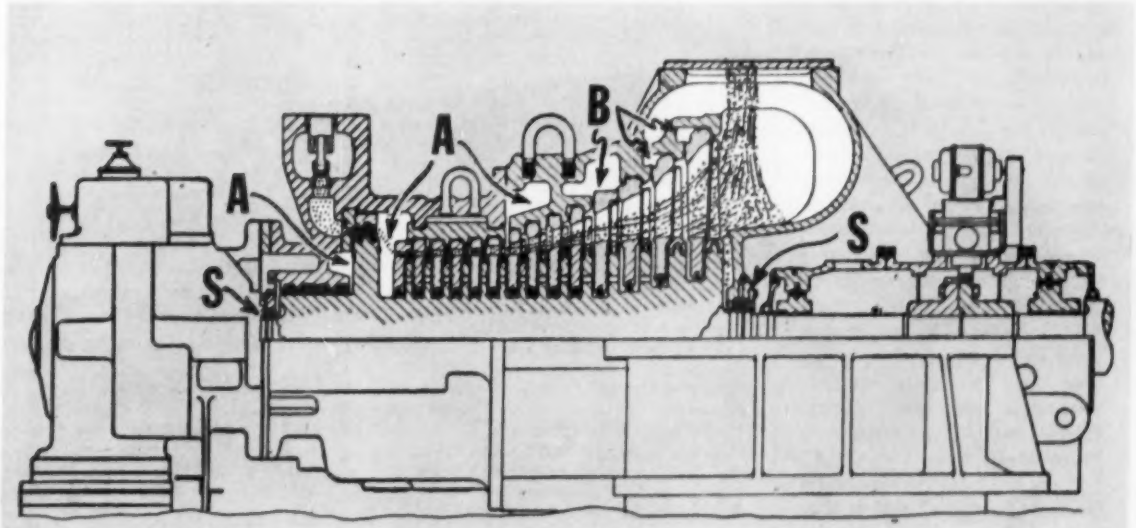
Operation

After extended outages, turbines must generally be considered to be full of air when the starting process is initiated. Air is much less effective than steam as a cooling medium.

Observation of many types and sizes of turbines during starting and loading and detailed examination of the same units during general overhaul, has indicated that pockets of high temperature air or steam-air mixture do develop.

This can often be noted by continual touch exploration of the exhaust hood, noting local cooling near the exhaust annulus of last stage wheels. This is sometimes followed by a sudden heating of the cool area before the general natural cooling after purging is complete when vacuum is swinging up toward normal.

Another indication became evident in the one-time mysterious vibration during starting of certain machines having shaft-mounted wheels with



Section of a single cylinder steam turbine, showing possible steam path conditions during starting. Dotted track is steam, the white surrounding area is air. "A" indicates drainage or bleed points normally under pressure during operation but subject to vacuum during starting. "B" shows drainage or bleed points where pressure differences are likely to be very low during starting, therefore not fully effective. "S" indicates shaft seals, sometimes a liability during starting

only one or two keys. Many instances of temporarily loose wheels have been identified.

Detailed examination of wheels, blading and nozzles will sometimes indicate that abnormal temperatures have occurred in some portion of the steam path. This is more common in the lower stages.

Conditions inside turbines do not assume a normal gradient until the initial mass of air has been purged from the turbine.

Condenser vacuum will not become normal *and* stable until this mass of air has been extracted. In most cases the purge takes place in almost instantaneous form and causes transient reduction in vacuum because of blanketing considerable tube surface with air.

The foregoing points very definitely toward the desirability, if not necessity, for forcing the purging of any turbine at the earliest possible time in the starting sequence.

On small units and any cases where initial temperatures are not over 750 F and where atmospheric relief valves are in use, it is usually practicable to start a unit rolling noncondensing. This will probably require enough steam to lift the atmospheric relief valve, and it has been found to purge the turbine effectively. The technique is to open the control valve(s) very rapidly and then trip the emergency trip by hand as soon as the shaft turns.

It is usually practicable to start circulating water on the condenser before opening the main throttle. Air removal and other condenser processes should be initiated at the moment the initial steam flow is interrupted.

The condenser is expected to gain vacuum fast enough to accept sufficient steam to keep the unit rolling.

This sequence has been found to produce starts free of vibration, quick vacuum pick-up and logical smooth temperature build-up in units where it is applicable.

Older units having simple water seals are started in this manner but brought up to sealing speed before cutting off the flow of steam. In these units vacuum develops slowly due to heating of exhaust ends and the condenser, but there is little danger of erratic local heating. If the seals become fully effective before the condenser is started there should be comparatively little air present.

For higher temperature conditions —unless provision for matching steam and metal temperatures is provided — compromises must be resorted to. This is doubly true where no atmospheric relief valve is installed.

The high temperature handicap calls for running long enough to establish satisfactory temperature relations in the first stage before any attempt at high flow purging.

The limitation of a bottled-up condenser requires that sufficient vacuum (steam condensing capacity) be effective to accept a rate of steam flow that will effectively purge the turbine.

Each large high temperature unit should be studied to determine its starting characteristics. Some may be found to be self purging in the initial rush of steam as the unit comes off its turning gear.

If indications of erratic temperatures are found, a strenuous effort should be made to develop a technique for purging at the earliest possible moment.

This must strike a balance between the risks involved incident to temperature differences between metal parts and mass flows of steam in the high pressure end (generally well-known values) vs the possible temperature differences in internal zones of the unit, which must be estimated.

Another Associate Editor Wanted for POWER ENGINEERING

AS A RESULT of our recent advertisement, we have added one well-qualified electrical engineer associate editor to the POWER ENGINEERING staff. We have another opening for a mechanical engineering graduate, between 30 and 45, with broad steam-electric plant operating experience in utilities and/or industry. Holding of PE license would be an advantage, as would some knowledge of diesel, hydro, refrigeration and compressed air.

The man we want must have a good personality, like to travel some, and investigate new developments over the country. Previous *editorial* experience is not required.

If you are interested and meet these specifications, send a photograph and resumé of your experience to the Editor, POWER ENGINEERING, 110 S. Dearborn St, Chicago, Ill.

New Way to Measure Generator Field Temperature

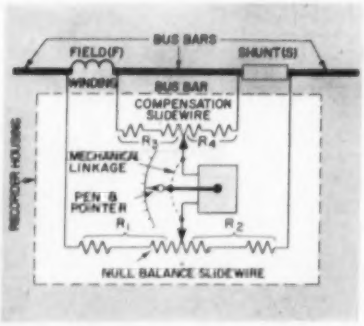
COMBINING a known electrical principle with standard recording instruments, General Electric's Instrument Department engineers have developed a new method to measure generator field temperature. It combines a Kelvin double-bridge circuit with an indicating recorder to relate conductor resistance changes to temperature of generator field windings. This instrument can be applied to all electric generators used in modern power generation plants.

Field temperature measurement is highly important to the safe and economic operation of electrical generators. Shorter insulation life or complete failure of insulation, causing permanent damage to the generator, could result from overheating.

Field temperature measurements in the new instrument system are based on the principle that resistance of copper or aluminum conductors changes with temperature. When resistance changes with temperature, the Kelvin double-bridge circuit is unbalanced, giving rise to an error signal at the recorder. The recorder balances out this signal error through a ratio system and indicates temperature of the generator field windings. The diagram shows how it works.

Recorder with a pen speed of 24 sec for full-scale response is used with the new measurement system. The pen speed is sufficient to follow any variations in temperature which may occur, and is slow enough so that the transients caused by field current changes will be minimized.

While this method of measurement is used mainly on a-c power generators, it can also be applied to field temperature measurements of d-c motors and generators, and synchronous motors, converters, and condensers.



Rotor temperature schematic showing input bridge circuit of recorder used to determine resistance changes accurately

Fig. 1. Sanmen Gorge on Yellow River is site of new 1,000,000 kw hydroelectric project. Channel at right will be reservoir

China Develops Big Hydro Systems

By TENG TSAI-SHOU*

OWING TO FAVORABLE natural conditions, China is one of the richest countries in water power resources. According to a study recently compiled, the government estimates that the total potential of China's water power, calculated on average stream-flow, amounts to 544,000,000 kw (see table).

This estimate included 1,598 big and small rivers and covered 70 per cent of the country. Total length of these rivers is 226,000 km (about 140,000 miles) and total run-off on average flow is 2617 $\times$ 10^9 cu m (about 92 $\times$ 10^{12} cu ft).

During the last six years the government has been paying particular attention to the development of hydroelectric power and water conservation projects, with a view to speeding up industrialization.

The following points give a general idea of the scale and speed of water power development in China at present and for the near future:

(1) Projects with capacities of more than 1,000,000 kw and with concrete volume of 2–3,000,000 cu m; (2) underground power house, or power house in the dam; (3) turbine-generator units of 80,000–150,000 kw capacities; (4) high-head plants with head up to 600–700 m (1968 to 2297 ft) for a single stage; and (5) relatively high construction speed.

At present, hydroelectric capacity has not yet reached 20 per cent of the total installed capacity in the country, but it is expected that the ratio will be raised to 28 per cent in 1962 and 40 per cent in 1967.

Power development on the big river systems includes important projects for the Yangtze, Yellow, Huai, Pearl, Brahmaputra in Tibet, Nu Kiang, Mekong, Irrawaddy, Red, and other rivers.

Scheme for the Yellow (Hwang Ho) River will completely develop the power resources of that river. According to the plan, there will be 46 stages in cascades, from Lungyang Gorge in Chingchai province to the sea, with a total installation of 23,000,000 kw, and a total energy production of 110 $\times$ 10^9 kwh per annum.

The Sanmen Gorge project (Fig. 1) with a capacity of 1,000,000 kw will be developed first, work being scheduled to start this year. The next to be constructed will be the Liuchia Gorge project, near Lanchow, also with 1,000,000 kw.

The Yangtze, China's largest river, is also under multiple-purpose development for hydroelectric power, irrigation, flood control, and navigation. Power plant sites are being considered for Yangtze Gorge near Ichang in Hupeh province, with a possible installation of 15–20,000,000 kw; for near-Chungking in Szechwan province, with 6,000,000 kw; a third at Ipin, also in Szechwan province, also with 6,000,000 kw.

In the last six years, the hydroelectric plants which have been put into commission, many damaged during the war period, include: the Kwanting plant near Peking, the Kutien plant in Fukien province, the new Shihlungpa plant near Kunming in Yunnan province, the Ulapei plant near Urumchi of Sinkiang.

Now under construction are new plants at Hwangtankow in western Chekiang province, the Shangyiu plant in southern Kiangsi province, the Ili plant in northern Yunnan.

* Engineer, Bureau of Hydroelectric Development, Ministry of Power Industry, Peking, China.

Fig. 2. Drilling being done on Liuchia Gorge project for Yellow River scheme

Table showing statistics on China's water power resources, biggest estimate ever made (1955). Government is pushing development of power for industry

No.	Water System	Potential Power (10^6 kw) at Q_{95}	at Q_{50}	at $Q_{aver.}$	% according to col. (5)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Grand Total	94	345	544	100.0	
1	Yangtze River System	42.2	144.9	217.0	39.9	
2	Rivers in Tibet	16.5	70.4	117.2	21.5	
3	Southwest International River Systems	12.3	53.6	90.6	16.7	
4	Hwang Ho System	8.5	24.0	32.7	6.0	
5	Chu Kiang System	4.6	16.5	28.5	5.2	
6	River Systems along Southeast Coast	3.8	12.4	20.4	3.8	Including Taiwan and Hainan Island
7	Northeast River Systems	1.3	9.7	18.9	3.5	Including Lwan Ho
8	Northwest Inland River Systems	4.6	12.7	17.5	3.2	
9	Hai Ho System	0.2	0.8	1.2	0.2	

Q_{95} = 95% duration flow; Q_{50} = 50% duration flow; $Q_{aver.}$ = average duration flow.

Fig. 1. Street view of boiler plant B

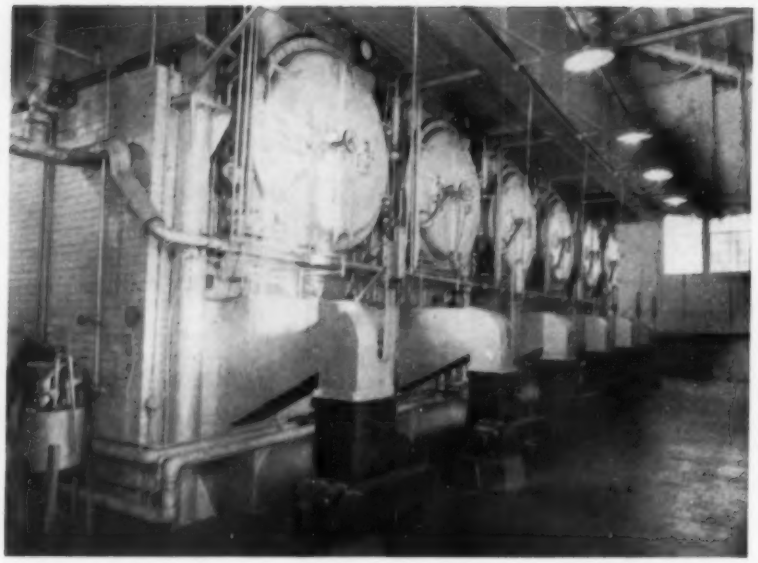


Fig. 2. After modernization, 6 72-in. oil-fed units on foundations of old boilers

This history of the modernizing of PLANT B is the second in a series of six such projects. The first appeared last month

What It Costs to Modernize

THIS PLANT, serving a well-known hardware manufacturer, has had an interesting history. It was constructed in the 1880's and as was quite usual at that time, had the firing floor about ten feet below street level so that a fair amount of coal could be stored under a trestle elevated as much as approach grades would allow, and yet could be wheeled in in barrows on the firing floor level.

It had 16 72-in. return tubular boilers with 18-ft tubes set in two batteries of eight each, economizer, and a 200-ft octagon bell-top, red brick stack, shown at right in Fig. 4. In this picture the boiler house building may be identified by comparison with Fig. 1, which shows the street end of the plant.

In 1926, increased business required additional power; also, bituminous coal had replaced the anthracite for which the original plant was designed and the boilers were replaced by new ones of the same size but set higher, and to get the draft required for increased capacity the economizer was removed and a new radial brick stack constructed. The fuel was coal, hand fired, brought in on a monorail by a dumping bucket from the coal storage at the left hand end of the building in Fig. 4. The trolley beam for the bucket can be seen in Fig. 3, which shows the old boiler house before alterations began.

These boilers operated at 165 lb and furnished steam to two Corliss engines which drove the mill shafting and some a-c generators. The engines were compounds and ran condensing but the cylinder arrangement was such that in winter one cylinder could be valved off to exhaust into the heating system. The condensers were of the jet type and took their water supply from a large cooling pond across the railroad tracks from the boiler plant.

As a result, the only returns to the boiler house were the heating system condensation and a small amount from process equipment, which from

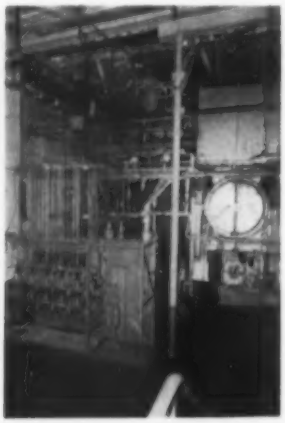


Fig. 5. New feedwater heater was installed. This view also shows rear of combustion control board seen in Fig. 6

COST OF MODERNIZING PLANT B: 1950-51

Boilers and settings, six 72" x 18'. Welded hrt boilers ASME Code for 150 lb pressure with settings, with air-cooled furnace walls and floor, present supporting steel raised 18"	Bigelow Co	$ 63,654
Raising and reconnecting flue	Bigelow Co	1,615
Removing 8 boilers and settings	Bigelow Co	1,725
Oil burning equipment: burners, wind boxes, forced draft fans, pump and heater set, two 30,000-gal tanks with enclosure, piping and wiring, combustion control and instruments	Peabody Engineering Co	58,965
Deaerating feedwater heater 50,000 lb per hr, 15 min stor.	Cochrane Corp through Turbine Equipment Co	4,977

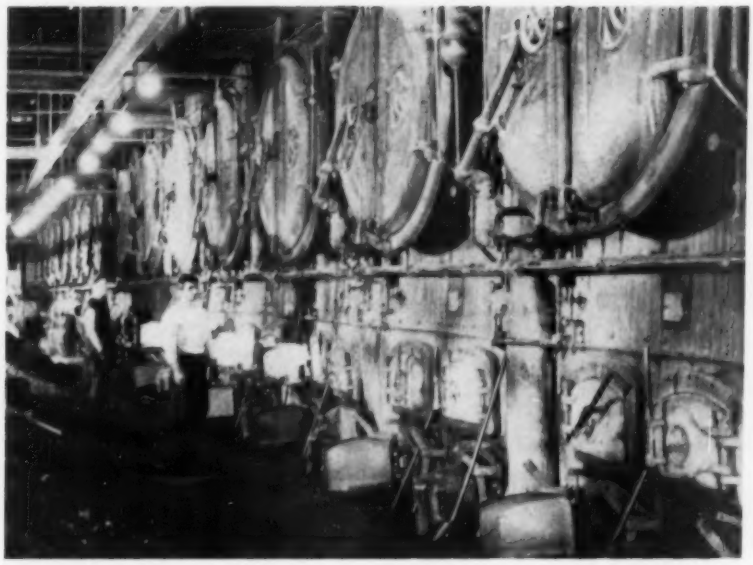


Fig. 3. Before modernization, boiler room bristled with total of 16 coal-fired units

Fig. 4. Original bell-top stack at right

Small Industrial Power Plants

By H. D. FISHER*

the use of vacuum pumps was highly aerated. The feedwater heater was too small and feed temperatures low, so that by the mid-1940's the boiler tubes were so badly pitted that frequent replacements were necessary and the insurance company recommended a complete retubing of the boilers.

The firing with coal was very wasteful, particularly in banking most of the boilers overnight, so a change to oil fuel promised worthwhile savings not only in this but in attendance. Also it was becoming increasingly difficult to hire men for hand firing. But as the existing boilers were of riveted construction with rather thick plates because of their high design pressure, it was considered undesirable to retube them and install oil burners in the existing settings.

While this part of the problem was under discussion, the frame of one of the Corliss engines developed a crack at the cylinder end of the crosshead guide and had to be abandoned. The plant had already been purchasing a portion of its electrical power from the local public utility and the substation installation was fortunately large enough to carry the increased load.

This reduced the estimated steam load to not over 50,000 lb per hour, and it was decided to install six 72-in. hrt boilers with 3-in. 18-ft tubes rated at 10,000 lb per hour each, on the foundations of six of the old boilers in one battery, and to use the space vacated by the two other boilers for auxiliary equipment.

These boilers were set with air-cooled furnace walls and forced draft steam atomizing oil burners, the forced draft fans drawing air down through the air-cooled walls, front through hollow tile in the furnace floor, and returning the heat picked up in its passage to the furnace. To get proper clearance for the oil

*Consulting engineer, Westcott & Mapes, Inc., New Haven, Conn.

Condensate storage tank, 5'-0" dia 11'-7½" long ⅜" shell, ½" dished heads	Williams Boiler Works	501
Support for heater and tank	Berlin Construction Co	3,218
Rigging of heater and tank onto support	Roger Sherman Transfer	712
Booster pump, motor, control	Ingersoll Rand Co	757
Blow-off tank, 3'-6" dia, 6'-0" overall, ⅜" shell, ½" dished heads	Williams Boiler Works	355
Engineering	Westcott & Mapes, Inc.	7,363
Subtotal		$143,842
Piping, building alterations, moving and assembly of miscellaneous equipment, etc., was done by the owner with his own maintenance force. Approximate expenditure		31,000
Estimated cost, $182,564. Approximate total cost		$175,000
Cost per lb per hour normal steaming capacity—$2.92		

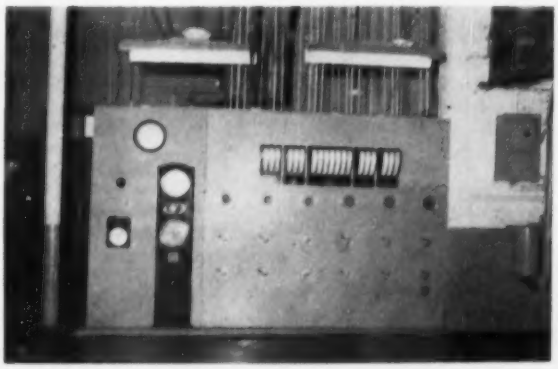


Fig. 6. This modern combustion control system was installed

burner flame from boiler shell and furnace floor the new boilers were placed 18-in. higher than the old ones by installing filler pieces on top of the boiler columns, as can be seen on the front of the near corner column in Fig. 2.

The flue over the new boilers was raised to correspond, the difference in level being taken up in the T-connection to the stack, as can also be seen in Fig. 2. The portion of the flue which had served the two boilers which were not reinstalled was removed and the oil-fired boilers depend altogether on the red brick stack. The eight remaining coal-fired boilers are served by the radial brick stack and were dried out and laid up for emergency service on coal should it ever be necessary to return to coal as fuel.

Two 30,000-gal oil tanks were installed abov- ground at the boiler house end of the coal storage yard, which is surrounded by a concrete wall, the coal trestle being shortened to accommodate them. The tanks were placed against the wall on the street side of the storage, enclosed on their open side by a 12-in. concrete wall and the space around them filled with sand. The fill pipes are placed in a curb box on the street beside the coal storage enclosure and the oil pumped into the tanks by the oil supply trucks. The coal trestle is at a sufficient elevation that oil can be delivered by rail if required.

The oil burners are of the forced draft, steam atomizing type with air registers. Ignition is by hand torch. To overcome the draft resistance of the furnace wall and floor air passages and provide the required midbox pressure, it was necessary to use centrifugal fans which were V-belt driven. A Cash combustion control system, the rear of whose control board can be seen in Fig. 5, was installed. The oil cylinders of this control for actuating fan and uptake dampers can be seen mounted on the fan discharge ducts in Fig. 2. The front of the control board with draft gages, feedwater meter and with the steam pressure recorder are shown in Fig. 6.

A deaerating feedwater heater was installed on an elevated platform between the two batteries of boilers, together with a storage tank for condensate. The condensate is pumped into this tank by the vacuum return pumps of the heating system. Makeup water from the city water system is introduced into this tank by a float-controlled valve. The heater and rear of the combustion control board are shown in Fig. 5. Figure 7 shows the deaerating feedwater heater (at left) and condensate tank with float control for makeup (at right) on the elevated platform, as well as the walkway, safety valves and steam outlets on top of the boilers. A booster pump on the firing floor level transfers the water from the condensate tank to the feedwater heater.

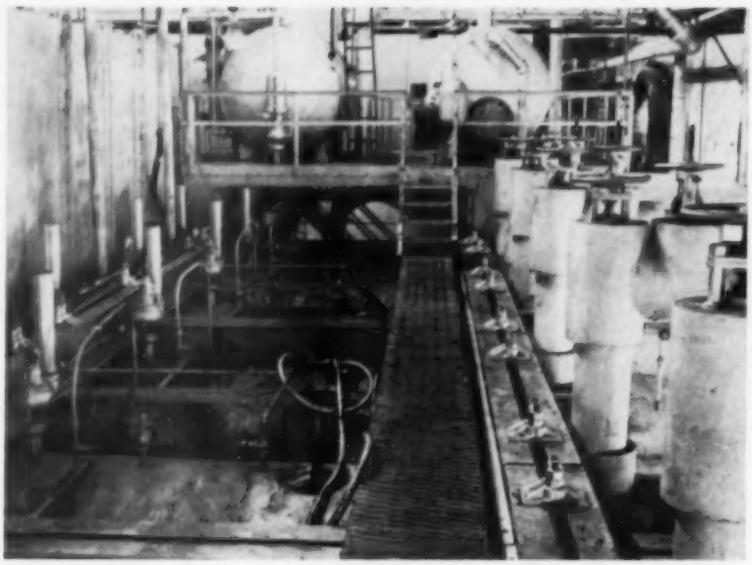


Fig. 7. Feedwater heater and condensate tank (r) on elevated platform, rear

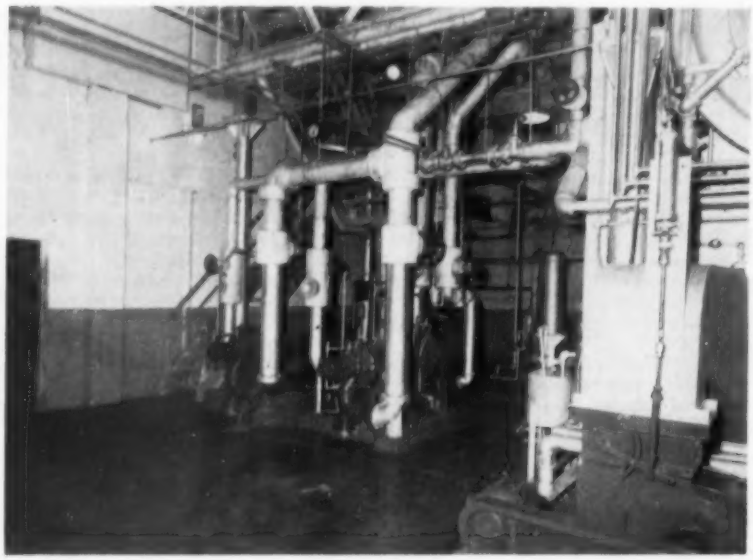


Fig. 8. Boiler feed pumps were relocated below feedwater unit, condensate tank

The existing centrifugal boiler feed pumps, one steam turbine and one motor driven, were relocated below the feedwater heater and condensate tank and are shown in Fig. 8. The pump and heater set for the oil burning system is located adjacent to the boiler feed pumps, portions of it being visible in Fig. 8.

In the four articles which will follow this one, H. D. Fisher continues his analysis—with actual cost figures—of how boiler plant modernization and expansion was successfully engineered for smaller industrial plants. How steam was maintained for mill operations during plant rebuilding is an interesting aspect of the case of Plant C, Fisher's third article, scheduled for next month.

Editor Kramer on the Neutron Circuit

IT IS a little hard for us to keep up with our editor's nuclear activities, they are so numerous and so far afield. Early March found him at the Red Canyon Proving Grounds of the U. S. Artillery in New Mexico, witnessing the firing of guided missiles (Nikes), which are now to be fitted with atomic war heads.

A week later he was in Oak Ridge as a Member of the Advisory Committee on Industrial Information to the AEC, working on declassification of technical material. From Oak Ridge, we found him going to Philadelphia to attend the Nuclear Congress the week of March 11.

After two days in the home office, he was off again, this time to participate in a panel discussion on atomic energy at the Society of Business Editors Meeting held at the Naval Research Laboratory in Washington, D. C. In Chicago, the following week we found him addressing the Chicago Building Congress at a luncheon meeting on Atomic Energy — Servant or Tyrant.

He is scheduled to talk at the Petroleum Electric Association annual meeting at Amarillo, Texas (Engineering Development in Russia); at the University of Pennsylvania on technical education abroad, and before local groups in Chicago. In his spare time, he manages to publish *Atomics* and make broadcasts over Station WFLN in Philadelphia on its Meet the Engineer program, sponsored by the Philadelphia section of the AIEE.

Fig. 1. Kramer addressing engineers

Fig. 2. Kramer (center) with General Homer, ICD and Mayor Cushman of Highland Park, Ill. at Red Canyon, N. M.

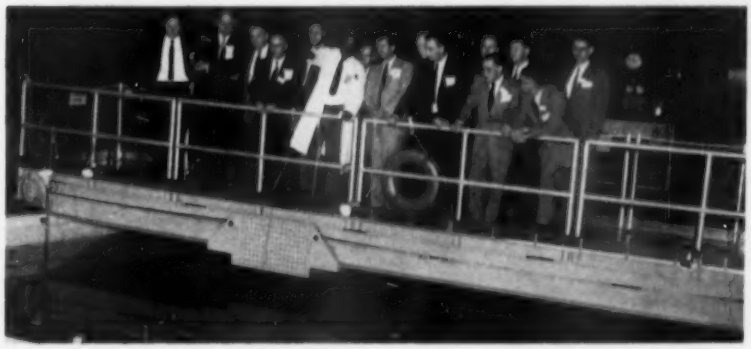


Fig. 3. Kramer (4th from left) with SBME group at U. S. Naval Research reactor

ASME Forms New Maintenance Group

NEW GROUP to deal with the increasingly complex engineering problems encountered in keeping industrial equipment in operating condition has been formed by The American Society of Mechanical Engineers, it was announced recently. The unit will cover such topics as modification of equipment and facilities to reduce or eliminate maintenance problems and prescribing corrective measures — including the development and use of special instruments — plus managerial activities such as organization, planning and keeping of records.

Chairman of the new group is Guerard Mackey of the E. I. du Pont Engineering Department, Wilmington, Del. As part of its program the group will sponsor technical papers to be presented at national meetings of ASME, and, in the future, may sponsor conferences in various parts of the country to consider special maintenance problems.

Objective of the group is to help keep engineers up to date on the new developments in the field of maintenance "needed to match the complexity of design and construction of the modern industrial plant today."

More than 200 members of ASME have indicated their interest in taking part in the activities of the new group. First technical papers under its sponsorship are expected to be presented at the Semi-Annual Meeting of the Society at San Francisco, in June.

Other members of the Executive Committee of the group are, Secretary, Robert H. Moore, Philadelphia Electric Co, Philadelphia, Penna., John K. Bryan, Union Electric Co, St. Louis, Mo., Benjamin G. Evans, Eli Lilly & Co, Indianapolis, Ind. and Arthur W. Weber, Corning Glass Works, Corning, N. Y.

Lab Test Facilities Now Available to All

FACILITIES OF THE Factory Mutual Laboratories are now being made available on a contract basis to organizations seeking help in product development or other research, according to a recent announcement by Norman J. Thompson, director.

Maintained by the Associated Factory Mutual Fire Insurance Companies, these laboratories have for 70 years been conducting research which has resulted in many outstanding contributions to safety in industry's rapid and complex progress.

An expansion program in recent years has resulted in a modern Laboratories building and an extensively developed fire and research testing station. Present-day facilities afford unusual opportunities not only to investigate fire and explosion phenomena, but also to undertake development in other fields, particularly in hydraulics, heat transmission, combustion processes and auto-oxidation.

Anyone interested in knowing more about the available facilities is invited to address a request for a copy of the new descriptive booklet, Research and Testing, to the Factory Mutual Laboratories, P.O. Box 510, Norwood, Mass.

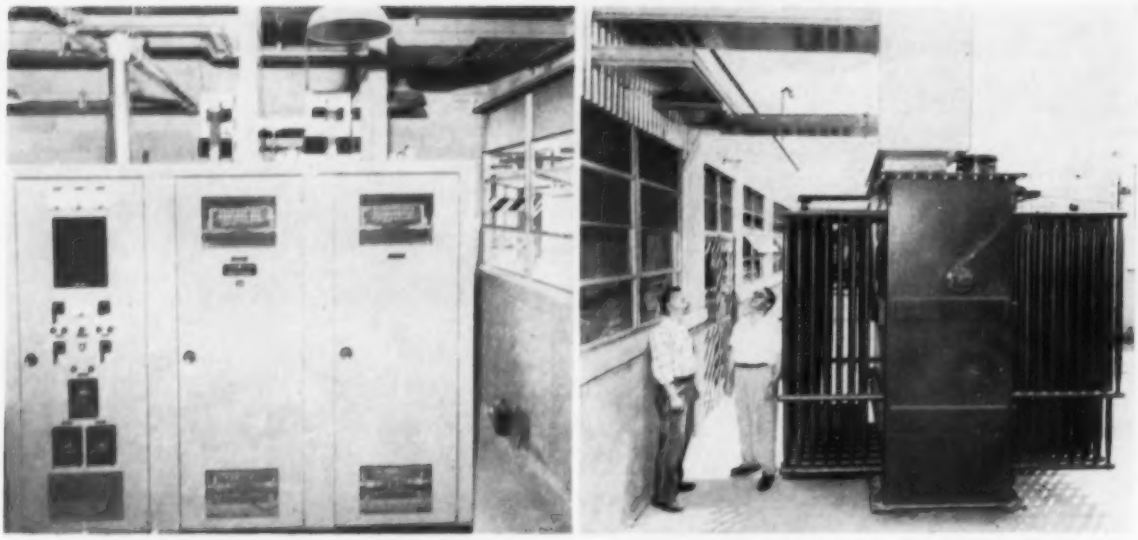
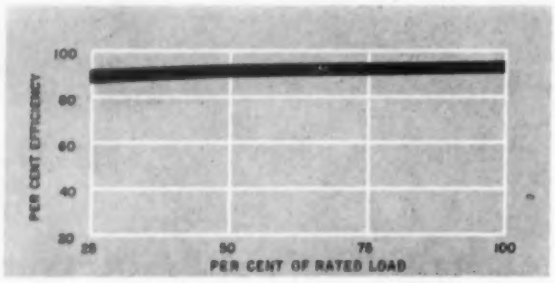


Fig. 1. Germanium rectifier (l) in hydrogen production installation. Rectifier transformer (r) is installed outside the building

Germanium Rectifiers Hit the Big-Time



By W. L. OVERSTREET*

Fig. 2. Dime-size wafer of germanium produces high efficiency. Graph shows typical efficiency curve for 75-v 8000-amp rectifier

GERMANIUM RECTIFIERS have now reached the point where they are no longer a curiosity or an experiment. Development, field experience, and resulting technological know-how have now given us the means to design a dependable, industrial-type d-c power supply from the little single crystalline disc of germanium shown in Fig. 2.

Since my article entitled What You Should Know About Germanium Rectifiers, which appears in the December 1956 issue of POWER ENGINEERING, was written, strides have been taken in this field which have definitely borne out our confidence in the advantageous use of germanium for such applications as heavy industrial electroplating, etching, electrocleaning, anodizing, gas production, aluminum processing, and a host of other electrolytic and electrochemical processes. Germanium installations totaling many thousands of kilowatts have been sold and installed to date by the General Electric Company. This large number of installations makes it possible to evaluate intelligently the rightful place of germanium in the broad field of direct current applications.

Typical of germanium rectifier applications in industry today is an anodizing installation in Kokomo, Ind., where the germanium rectifiers furnish 20 v at 8000 amp d-c, control of the output voltage, as required by the anodizing cycle, being provided by an Inductrol, located adjacent to the rectifier.

Another example is an installation supplying d-c power for electroplating in Jackson, Mich., where germanium rectifiers deliver 12 v at 45,000 amp d-c.

Figure 1 shows a rather different application — a germanium rectifier cubicle inside a building in Hickory, N. C., while the rectifier transformer, which has a primary voltage in excess of 600 v, is installed outside the building, with metal-enclosed busway between transformer and rectifier. This installation furnishes 65 v at 12,000 amp for hydrogen-gas production. Frequently, where a high voltage distribution system is available, this type of installation will prove economical.

Other installations too numerous to detail in this article include a 24-v, 20,000-amp rectifier for aluminum production in Louisville, Ky.; a typical steel mill installation outside of Chicago, where a 12-v, 10,000-amp germanium rectifier is used to tin-plate strip steel used in the manufacture of tin cans; and a gas-production plant in North Bergen, N. J., utilizing a 65-v, 16,000-amp germanium rectifier. These and many more such installations form the basis for the experience on which we can judge the performance of this germanium cell.

As pointed out in my previous ar-

*Rectifier Equipment Sales, Rectifier Dept., General Electric Co.

Fig. 3. Germanium cell is hermetically sealed in steel and ceramic housing

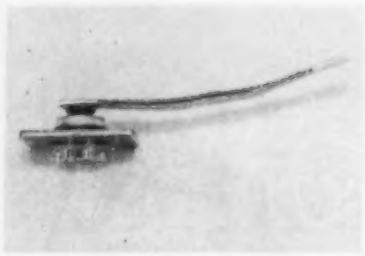


Fig. 4. Sealed cell is soldered to casting, cooling pins on under side

Fig. 7. Germanium cells in direct water-cooled rectifier, mounted vertically

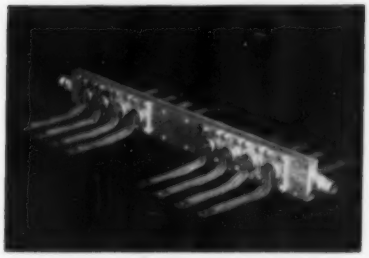


Fig. 5. Cell assembly is mounted on a hollow bus, using "O" ring seal

Fig. 6. For voltages over 150 v d-c, cells are mounted in removable tray

ticle, the main features of the germanium rectifier which make it an attractive d-c source for many applications are these:

(1) *High efficiency.* Efficiencies of around 94 per cent are quite common. Such high efficiency will continue to pay dividends to the purchaser for many years after installation.

(2) *Practically flat efficiency curve from 25 per cent load to 100 per cent load.* Frequently, d-c conversion equipments will display extremely poor efficiency characteristics when operated at appreciably less than rated output. Figure 2 shows a practically flat efficiency curve for germanium down to 25 per cent load.

(3) *No "aging" of germanium cells.* Selenium or copper oxide cells display the characteristic of a gradually increasing forward resistance with use, which is commonly referred to as "aging." After 20,000 to 60,000 hours of operation (depending on the quality of the rectifier cells and how close to equipment rating the load is maintained) these selenium or copper oxide cells will have aged to the point where they will usually have to be replaced. This replacement frequently costs around one-third the initial investment of the rectifier equipment itself. Germanium rectifiers do not display this aging trend.

(4) *No special foundations are required.* Some d-c power supply equipments require special reinforced foundations. Not so with germanium. Nothing rotates on a germanium rectifier except the cooling fans. A floor or balcony structure sound enough to carry dead weight of the germanium rectifier is adequate.

(5) *Small size and weight.* Due to the proven sound practice of obtaining around 333 amp d-c per sq in. of germanium rectifier, it can easily be seen how weight and space savings can be realized. In comparison for the same type of circuitry, selenium is commonly rated at 0.480 amp per sq in. of rectifying area.

After consideration of the above advantages, the history of the effectively operating installations, and recognizing the favorable economic relationships germanium now enjoys with its competitive forms of a-c d-c conversion equipment, it is easy to understand why the use of germanium has grown so phenomenally over the past three years.

Design Progress

Now that we know the chief advantages and growth picture of the use of germanium, let's take a look at the most recent design progress.

It has been noticed that germanium crystals when left open to the atmosphere are prone to absorb moisture or other foreign substances. It has been concluded that such absorption may cause fluctuating characteristics of the germanium rectifier junction. Potting compounds were tried but they did not offer the long-range protection desired for an industrial application.

Finally, the little germanium crystal shown in Fig. 2 was soldered on a copper block (for fast heat dissipation) and then enclosed with a ceramic, welded, hermetic-sealed metal housing, as indicated in Fig. 3. This welded hermetic seal offers life-time protection to the germanium against any foreign substances which may effect its rectifying characteristics.

This sealed germanium cell is then soldered onto a casting with cooling pins protruding from the under side and a flexible lead is then soldered to the other side of the cell (Fig. 4).

This cell assembly is then mounted on a hollow bus, as indicated in Fig. 4, using an "O" ring seal to prevent water leaks. This hollow bus has been mounted inside of the rectifier cubicle which generally will contain other components such as the rectifier transformer and cooling fans, to present a packaged d-c source (Fig. 7).

The hollow bus cooling system allows the purchaser to feed his own raw water into the rectifier, into the bus and across the cooling pins of the germanium rectifying elements. Herein lies another excellent advantage — all of the rectifier element heating losses are carried off by the water. In instances where the purchaser's water supply contains too many impurities, a water-to-water heat exchanger can be added and pure water circulated through the rectifier tubes and heat exchanger in a closed loop.

The above described design gives a simple, economical and compact equipment for d-c requirements from 2000 amp up and up to 150 v d-c.

For voltages over 150 v d-c it has been found more economical to mount the hermetically sealed cell shown in Fig. 3 on a cooled fin assembly and mount the cells assembly in a tray (Fig. 6). These trays slide into the rectifier cubicle and make contact to the a-c and d-c bus by means of a sliding contact. This makes the tray easily and quickly removable.

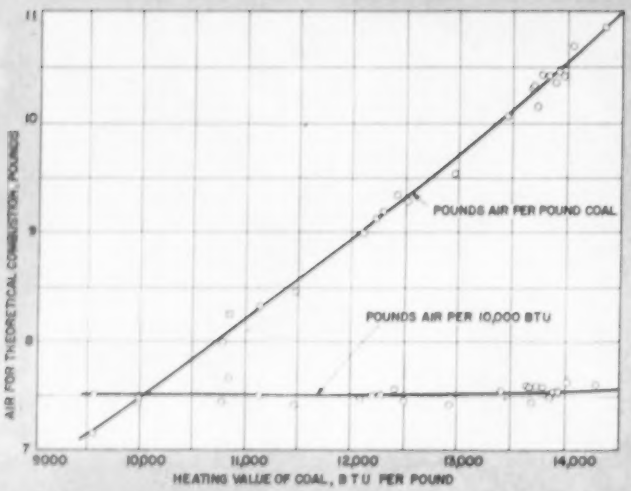


Fig. 1. Theoretical amount of air, in pounds, for combustion of different coals; from paper by P. Dickey, Bailey Meter Co

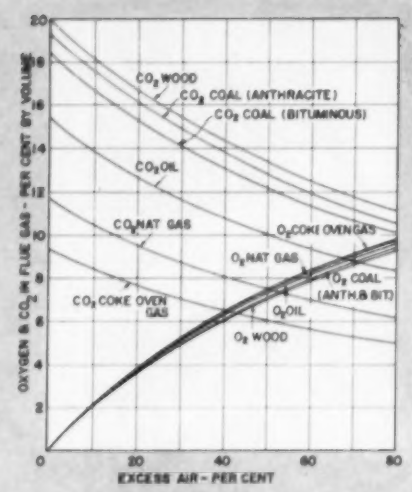


Fig. 2. Excess air vs oxygen and CO_2 in flue gas (Barnard, Bailey Meter Co)

HERE'S HOW TO

Cut Costs With an O_2 Analyzer

Rising fuel prices, says author, demands you get utmost efficiency in combustion. Here's how and why O_2 analyzers make this possible

By H. B. LAMMERS *

MODERN POWER PLANTS are well designed, constructed, instrumented and operated. They are designed to operate at maximum capacity for long intervals of time, using a minimum of labor; they are designed, in short, for efficient operation.

Many problems encountered in the old plant have been eliminated. However, increased attention is being given to efficiency of combustion and reduction of maintenance costs. Increased furnace maintenance can be traced frequently to the combustion process. Improper combustion results in reduction of productive capacity, inability to maintain maximum capability of the unit, and increased maintenance costs.

Combustion in the modern furnace is influenced by many factors; to operate at maximum efficiency is becoming increasingly difficult because boilers and process equipment are gaining in size and complexity. Furnaces are getting larger, firing equipment more complex. This is so because many plants are designed to burn more than one fuel, and to burn them in combination. This requires more complex instrumentation and combustion controls to attain maximum efficiency.

Modern utility stations, employing the single-purpose boiler-turbine unit, are more critical of fuel supply and combustion than were their predecessors. This is evident because of furnace arrangement, since many units employ twin furnaces, by-pass dampers, and tempering air arrangements; there is complex steam and reheat control, difficulties of metering and proportioning fuel and air, and like complexities.

Efficient combustion takes on added significance with rising fuel prices as production costs are related to fuel costs. Reduction of losses in the combustion process may in itself result in attractive savings, but there is the added probability that reduction of maintenance resulting from improved combustion will occur and thereby also improve the availability factor. In still other processes, efficient combustion results in an improved product.

Combustion control systems are employed to maintain efficient combustion. A control system is no better than the analyzer employed to check combustion efficiency. The analyzer must provide an accurate index of combustion in order to maintain air-fuel ratios; these ratios must remain constant regardless of whether one fuel or several fuels are burned in combination. Each 10 per cent of excess air, in excess of that required, is accompanied by a loss of approximately 1 per cent of the fuel. If *less* air is provided than is required, losses may be 10 per cent or more for each 10 per cent deficiency in excess air, due to the combustible loss in the exit gases.

For example, a single large utility boiler may consume 400,000 tons of coal or coal equivalent per year — or more. Assuming a coal cost of $6 per ton, and a loss of 1 per cent by reason of 10 per cent air in excess of that required, the loss would approximate $25,000 per year. An oxygen analyzer is capable of effecting such savings; many companies employing oxygen analyzers report savings far in excess of this.

Principles of Combustion

A review of the principles of combustion will help to make clear the merits of the oxygen analyzer.

Combustion may be defined as the phenomenon resulting from a chemical combination evolving heat, or as

*Chief Engineer, Appalachian Coals, Inc.

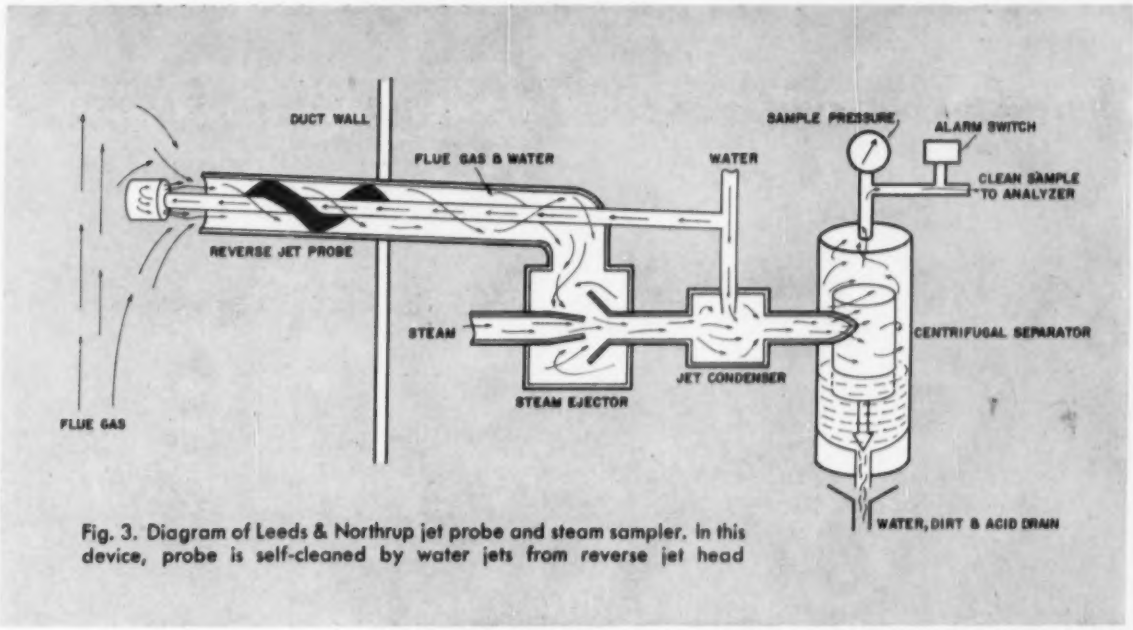


Fig. 3. Diagram of Leeds & Northrup jet probe and steam sampler. In this device, probe is self-cleaned by water jets from reverse jet head

the rapid combustion of the combustible elements (C, H, S) in fuel, in presence of *oxygen*. Oxygen is the sole supporter of combustion, and is the only reliable index of combustion.

Combustion elements in all fuels are similar, whether found in a free or combined state. If completely burned, they produce the same heat per pound. Simply feeding these elements into a furnace provides no assurance that the combustion process will be complete or efficient — or free of explosive hazard.

In the furnace, carbon may be converted to CO_2; accompanying this conversion is a heat release of 14,540 Btu per lb of carbon. However, due to a deficiency of air (O_2) or poor turbulence, the carbon may burn to carbon monoxide, with a heat release of 4380 Btu per lb of carbon. A loss of 10,160 Btu per lb of carbon (14,540 – 4380) accompanies the latter process. Carbon may pass through the furnace without burning, in which case the entire heat potential is lost. Likewise, free hydrogen (H_2) may exist in the exit gases, a loss of 62,000 Btu per lb of H_2 is then experienced. Presence of combustible gases (CO and H_2) in the exit gases may result in a disastrous explosion.

Combustion usually occurs in an oxidizing atmosphere in which an excess of air (oxygen) is provided to insure complete combustion. It is desirable, however, to reduce the excess air to a minimum to avoid gas losses. Reducing the excess to a minimum, however, may result in the losses increasing instead of decreasing because of the presence of CO and H_2 in the exit gases, plus introducing the danger of explosion. Combustion also occurs in furnaces operating with a reducing atmosphere. Here, likewise, the correct fuel-air ratio must be maintained if maximum efficiency is to be secured with safety. Analysis of furnace gases is the only manner in which the efficiency of combustion can be determined.

Combustion Analyzers

Analyzers employed to check combustion efficiency are the orsat, CO_2 recorder, and the oxygen analyzer.

An **orsat** is frequently used to analyze combustion gases and to determine combustion efficiency. It is also used to check other analyzers (CO_2 and O_2 recorders), to calibrate steam-air flow meters, and as a check on combustion control. The disadvantages of the orsat lie in the time required to complete the analysis, and in the fact that a very large number of samples must be taken simultaneously to keep abreast of changing combustion conditions. In the time interval between samples, furnace conditions can alter to a considerable extent unless correlation is made with the many factors that affect combustion at the instant of sampling; analyses of results are extremely difficult.

The orsat has a further disadvantage in that it does not provide a continuous record of combustion conditions, nor can it be inserted in the combustion control circuit to readjust the fuel-air ratio automatically.

A **carbon dioxide analyzer**, unlike the orsat, is not a reliable index of combustion, unless the C/H ratio of the fuel is known and remains relatively constant. It presupposes as a result of the orsat analysis, that carbon monoxide (CO) is not present. Furthermore, when two or more fuels, or dissimilar fuels, are burned, the CO_2 meter is unreliable unless the quality and quantity of each fuel is known. This is so because the CO_2-excess-air relationship varies with each fuel or combination of fuels. For furnaces operating at low excess air, or in combustion processes operating with a reducing atmosphere, the CO_2 analyzer may be considered unreliable as a combustion index.

Nevertheless, when a CO_2 analyzer is employed to analyze the combustion gases from a single fuel or fuels having a constant C/H relationship, it may be considered as a satisfactory index of combustion. The analyzer has for years been employed to advantage when consideration has been given to its limitations; it is responsive and can provide a continuous record of combustion conditions. Under these circumstances, it can be inserted in the combustion control circuit to readjust fuel-air ratios.

The **steam-air flow meter** has been established as a reliable instrument for metering and proportioning fuel-air ratios. Its accuracy, like that of the CO_2 meter, depends on accurate measurement of steam-air flow, but only *after* an orsat analysis has been made of the combustion gases and it has been determined that combustion is complete. When fuels are burned in combination, the air flow meter does not provide a really accurate index of combustion.

Having established by orsat analysis that the fuel-air ratio is correct for

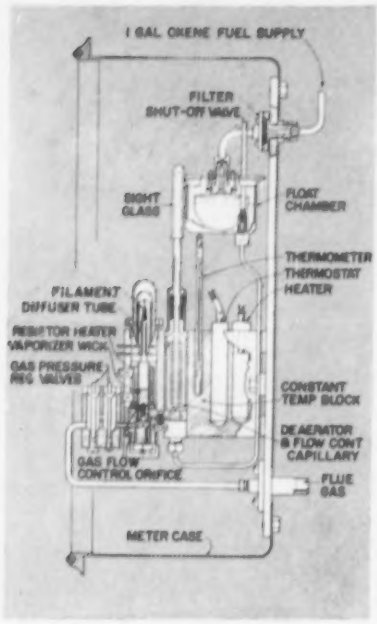


Fig. 4. Cutaway view of Bailey oxygen analyzer. Oxene supply tank not shown

a given furnace, the steam-air flow ratio can be calibrated and be made to maintain these ratios within a reasonable degree of accuracy over the range of output of the boiler.

Reference to Fig. 1 indicates why the steam-air flow meter can be very accurate when coal is burned. Although the heating value per pound of coal varies to a very considerable extent, note that the pounds of air per 10,000 Btu, is, for all practical purposes, constant. The curve representing pounds-of-air per pound-of-coal bears a straight line relationship to the heating value of the coal.

Hence, steam output (flow in Btu) and air flow can be made to indicate correct combustion efficiency — again, only and *after* the combustion gases have been analyzed to determine whether combustion is complete. This must be determined for each and every fuel or fuel combination and for each and every furnace in which combustion takes place, since there exists but *one* best fuel-air relationship. This relationship must be determined in advance of the meter's calibration. When steam-air flow meters are applied to liquid and gaseous fuels, and the quality of the fuel remains unchanged, the meter can likewise maintain the desired fuel-air ratio within close limits. In all cases, the meter is dependent for its accuracy on a prior gas analysis.

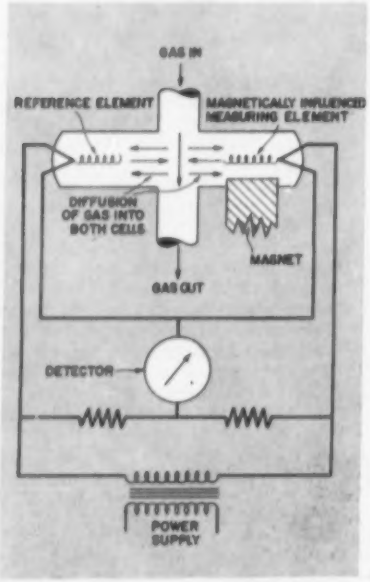


Fig. 5. Measuring circuit of Leeds & Northrup instrument—a magnetic type

Fuels and Combustion

The CO_2 analyzer and the steam-air flow meter can therefore be used as an index of combustion for various fuels within the limits specified. That oxygen is more nearly related to excess air than is the CO_2 content of the combustion gases is evident from Fig. 2. Since oxygen is the sole supporter of combustion, its presence is a true index of excess air and efficiency of combustion.

For individual fuels or combination fuels (Fig. 2) the oxygen-excess-air relationship may be found to lie in a narrow band. Reference to the CO_2-excess-air relationship for fuels of varying quality and/or for combination fuels, shows that this same close relationship does not exist.

Many modern plants burn two or more fuels in combination and in varying percentages. For reasons previously mentioned, the CO_2 analyzer and steam-air flow meter are unreliable as an index of combustion.

This is immediately obvious from the following example. Assume bituminous coal and natural gas are burned in a common furnace (see Fig. 2). At 20 per cent excess air, the CO_2 for coal would be approximately 15.3 per cent and for gas 9.7 per cent. The CO_2 content would of necessity be related to both the quality and quantity of each fuel. Such quality and quantities are difficult to determine and meter, and complicated metering and proportioning devices must be employed if the correct fuel-air ratios are to be maintained.

If, however, oxygen (O_2) is to be used as an index of combustion, the 20 per cent excess air would be very nearly the same (3.6 per cent O_2) for the above combination regardless of the quantities burned. This same comparison can be made for any other fuel or combination of fuels. It is apparent, from Fig. 2, that O_2 is more nearly related to excess air. The value of the oxygen analyzer as an index of combustion is immediately evident.

When operating in the low excess-air range or when combustion occurs in a reducing atmosphere, the oxygen analyzer in turn will not be a true index of combustion by reason of the presence of combustibles (CO and H_2) in the furnace gas. In this case, a combustibles analyzer must be used to supplement the oxygen analyzer. The combustibles analyzer determines the presence of CO and H_2, and informs the operating staff of the presence of combustibles. This instrument can then be made to operate on alarm or to interrupt the fuel supply to avoid an explosion. Modern furnaces are critical of combustion, since combustion can affect a change in steam output, steam and reheat temperatures, which in turn affect turbine performance. Poor combustion likewise increases slag deposits and the maintenance resulting therefrom.

Oxygen analyzers are reliable, dependable and necessary instruments in the modern power plant. They are considered to be an accurate index of combustion; they can be inserted in the combustion control circuit to modify the fuel-air relationship to secure efficient combustion.

Oxygen Analyzer

The oxygen analyzer is being used in many industries and for many purposes. They are used for industrial and utility coal-burning stations, employing underfeed, overfeed, and traveling chain-grate stokers, as well as pulverized fuel and cyclone operation. In plants burning combination fuels, the analyzer is considered a prerequisite. In modern utility boilers equipped with twin furnaces and operaing from complicated control systems, performance is improved when oxygen analyzers are employed.

Oxygen analyzers find application to heaters in the oil refinery industry, and to rotary kilns in the lime and cement industry. For the pulp and paper industry where combination fuels, bark, black liquor recovery, etc. is burned, they are very highly recommended. In the steel industry, application has been made to open hearths, soaking pits, continuous annealing furnaces and special process furnaces; they are used to a limited extent for blast furnaces.

Oxygen analyzers are adaptable to processes employing a reducing atmosphere. When operating with a reducing atmosphere or at extremely low excess air, they should be supplemented with a combustibles analyzer.

Fuel savings have been reported by many companies using the oxygen analyzer. A definite value in terms of constant steam and reheat temperatures are difficult to arrive at, since many of the newer generating stations have no before-and-after experience, having installed the analyzer at the outset. Other industries

report that the analyzer assists in producing a more uniform product, while also increasing production and reducing fuel costs. In the cement industry, fuel savings of 5 to 20 per cent are reported.

Like any other gas analyzer, the first prerequisite is to secure a representative gas sample. Since no one has yet determined the one best location from which to take a sample, the practice of gas sampling or flow measurement is usually undertaken. Large furnaces and those employing twin furnaces will find it advantageous to install two analyzers. The practice frequently employed — that of using a multiple number of sampling connections for any one instrument — is not recommended, unless facilities are provided so the analyzer can be made to switch from one to the other. The analyzer should be installed so as to reduce time lag to a minimum.

Many of the problems previously encountered when using the analyzer (corrosion, line stoppage, deterioration of sampling tubes, etc) have been largely overcome. Alloys and stainless steel are employed in the construction of sampling tubes and instruments; water sprays, scrubbers and filters do an effective job of removing impurities.

A letter of inquiry to various industries (steel, cement, utility) indicates that maintenance is not excessive, averaging approximately 9 hours per week per instrument. Several companies report as low as 4 manhours per week — several as high as 14 manhours per week. Calibration of the instrument is required on the average of once per week, although several companies report recalibration once every 3 to 6 weeks. It would appear that once a week is most desirable since the combustion process and control are dependent on correct fuel-air ratios.

Maintenance is reported as somewhat higher if sampling is done in extremely hot or dirty zones, but for the most part, companies reporting did not believe this to be excessive. Many companies use steam and compressed air daily to blow back through the sampling line.

Assuming 15 manhours per week at $2 per hr, or $1500 per yr to effect a 1 per cent fuel saving is certainly not excessive to achieve $25,000 or more per year in savings.

Continued performance of the oxygen analyzer is contingent upon securing a clean sample of gas. In the case of the Leeds & Northrup instrument (Fig. 3), the gas sample is drawn through the reverse jet probe by the steam ejector. In this sampler, the probe is kept clean by three high-velocity water jets from the reverse jet head and spiral spacer which gives a swirling action to the flue gas and water mixture. Hence, the probe is flushed out continually. Cleaning of the flue gas is accomplished in the first stage (jet condenser), where water and steam combine to envelop the minute dust particles. In the second stage (centrifugal separator), water and impurities are removed by centrifugal force permitting a clean sample to pass to the analyzer.

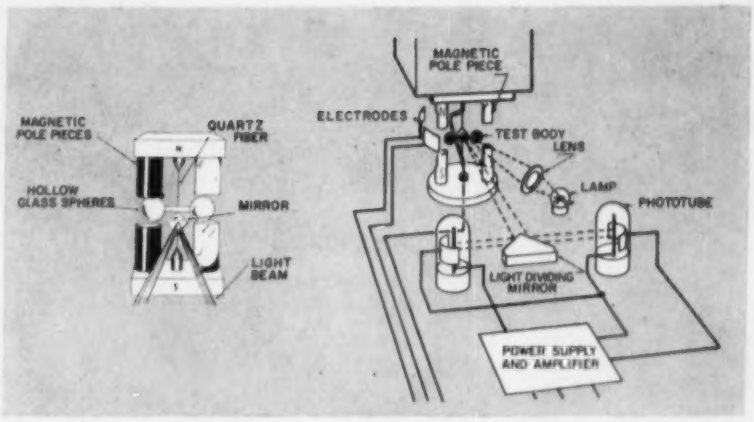


Fig. 6. Beckman O_2 analyzer uses paramagnetic property of oxygen to determine O_2 content; it measures magnetic susceptibility of gas with a torsion balance

Oxygen analyzers are manufactured by a number of companies, such as Beckman, Hays, Leeds & Northrup and Bailey Meter. The first three operate on a magnetic or thermomagnetic principle, Bailey on the principle of catalytic combustion.

Bailey Oxygen Analyzer

This analyzer is employed for a continuous analysis of the volumetric percentage of oxygen in another gas or in a mixture of gasses. It is also used for the determination of excess air in a combustion process. The analyzer operates on a catalytic combustion principle. It combines a gas sample with a standardized fuel in a chamber of a heated, noble-metal catalytic filament which causes a combustion process to take place. The heated element is one leg of an a-c Wheatstone bridge, which, through variations in resistance of the filament due to the heat of the combustion process, measures the percentage of O_2 present in the gas sample on a volumetric basis.

As indicated in Fig. 4, a continuous sample of gas of which the oxygen content is to be measured is drawn from a flue gas sampling point and delivered to the analyzer where it is combined with oxene, a standardized fuel (*Note*: Hydrogen can be used in place of oxene). The mixture is burned catalytically by means of a heated noble-metal filament. Because of its initial temperature and material, the filament acts as a catalyst in the burning process. If oxygen is not present in the gas sample, no combustion takes place in the filament chamber and hence the filament remains at its initial temperature. As the Wheatstone bridge is balanced so that there is no output voltage from the bridge under these conditions, the recorder will continue to read zero.

However, when O_2 is present, combustion occurs in the filament chamber. Chamber temperature will increase in proportion to the amount of O_2 present because of increased heat release. This in turn raises the filament temperature, changing the resistance of the filament, and producing an unbalance in the measuring circuit. The unbalance voltage is proportional to the amount of O_2 in the sample.

The system has three main components: fuel system, gas control system, electrical system. Oxene (fuel) is fed to the analyzer, passed through a filter to a constant level float chamber and thence to the deaerator. In the deaerator is a flow control capillary tubing having a fixed fluid resistance. A constant fuel flow is provided by reason of the capillary as well as the constant head in the fuel bowl. The deaerating chamber is heated to maintain constant volume and uniform fuel viscosity and flow while deaerating the fuel. Oxene flows from the capillary to a vaporizing wick, made of porous ceramic, surrounded by a resistor heater that causes the fuel to vaporize. The filtered gas sample is delivered under pressure to the analyzer and to the pressure regulating gas valves, which maintain a constant predetermined pressure. The arrangement is such that approximately 1 per cent of the gas sampled is used for analysis, the other 99 per cent reaching this point being exhausted to the atmosphere. This method permits a high rate of flow from the sampler and reduces the time lag.

Gas at a constant pressure established by the regulating valves passes into the orifice plug, through the gas flow-control orifice, to the vaporizer wick, and mixes with the vaporized fuel. The gas-fuel mixture passes up and around the filament where catalytic combustion between the fuel and any free O_2 in the sam-

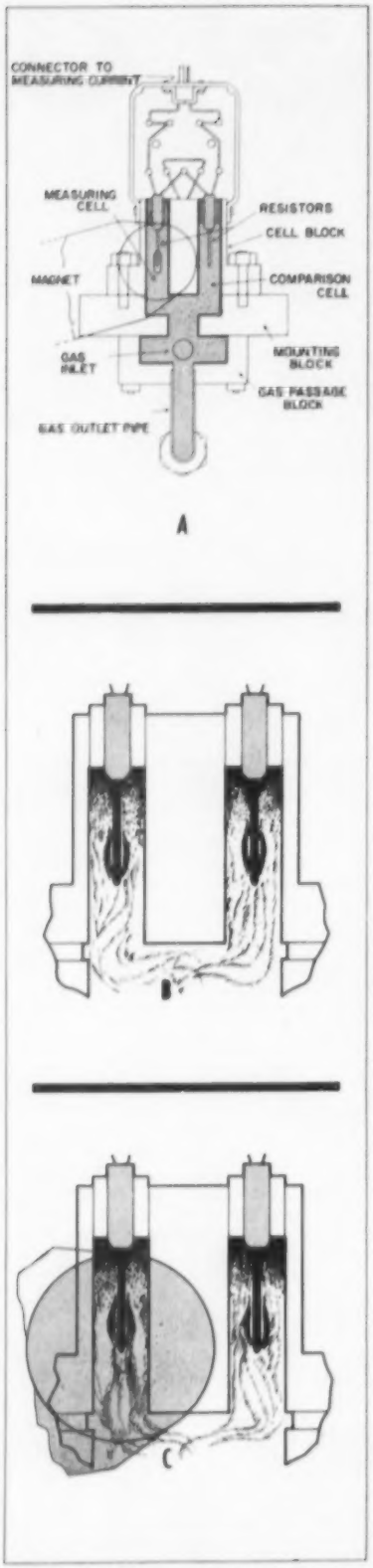


Fig. 7. Hays analyzer also uses paramagnetic principle; top view shows an overall schematic, lower views, how the gas acts in and out of magnetic field

ple occurs. The combustion gases are discharged to the atmosphere.

Leeds & Northrup Analyzer

The L & N. analyzer employs the magnetic principle of O_2 measurement. The elementary measuring circuit is shown in Fig. 5. Two electrically heated resistance elements are employed; one is the reference element, cooled by thermal convection currents, the other, the measuring element, cooled by thermal and magnetic convection currents.

If O_2 is not present in the measuring cell, thermal convection currents only are present to cool the elements in both cells, hence the meter remains in balance. However, when O_2 is present in the measuring element, the combined actions of the thermal and magnetic convection currents in this cell alter the temperature of the element as a result of the changes in the rate of heat loss. Since thermal convection affects both cells, the signal is due to the magnetic influence.

The principle upon which the instrument operates is this. Oxygen is paramagnetic (can be drawn into a magnetic field) while most other gases found in combustion processes are not. This results in a magnetic convection current being generated in the gas, and this current cools the wire in proportion to the paramagnetic activity of the gas. The resulting temperature is measured by change in wire resistance and recorded as O_2.

Barometric or static pressure would affect the accuracy in the above elementary circuit. This is eliminated in the instrument by incorporating a second bridge circuit (not shown), that operates on air and is similar to the elementary current shown. Changes in pressure have an equal effect on both bridges and cancel.

The elementary circuit shows a reference element and a measuring element. Gas from the point of sampling passes through the probe, is cleaned and introduced into both cells. Thermal convection currents cool the measuring element. The unbalance in the measuring circuit by reason of the quantity of oxygen present is recorded.

Beckman O_2 Analyzer

This instrument likewise employs the paramagnetic property of oxygen. It determines the O_2 content by measuring the magnetic susceptibility of the gas with a magnetic torsion balance.

A light dumbell is supported on a quartz fiber between magnetic pole pieces (Fig. 6). Each ball of the dumbbell is in a non-uniform magnetic field. The dumbbell itself has a fixed magnetic susceptibility. When a sample of gas containing oxygen surrounds the dumbbell suspension, the suspension experiences a force dependent upon the difference between the magnetic properties of the gas and the suspension itself. The effect of the force exerted tends to rotate the dumbbell about the quartz fiber. The magnitude of this force is proportional to the oxygen content of the sample gas.

The balancing potential is measured as follows: Attached to the suspension is a mirror from which a light beam is reflected. This beam is divided between two photo tubes. The output of the photo tubes is in balance when the suspension is in its null-position. However, when the suspension rotates, the amount of light on the tubes is unequal, producing an unbalanced output from the tubes. This unbalance signal is amplified; the rebalance potential required to return the suspension to its null-position is measured in terms of oxygen in the gas sample.

Hays Oxygen Analyzer

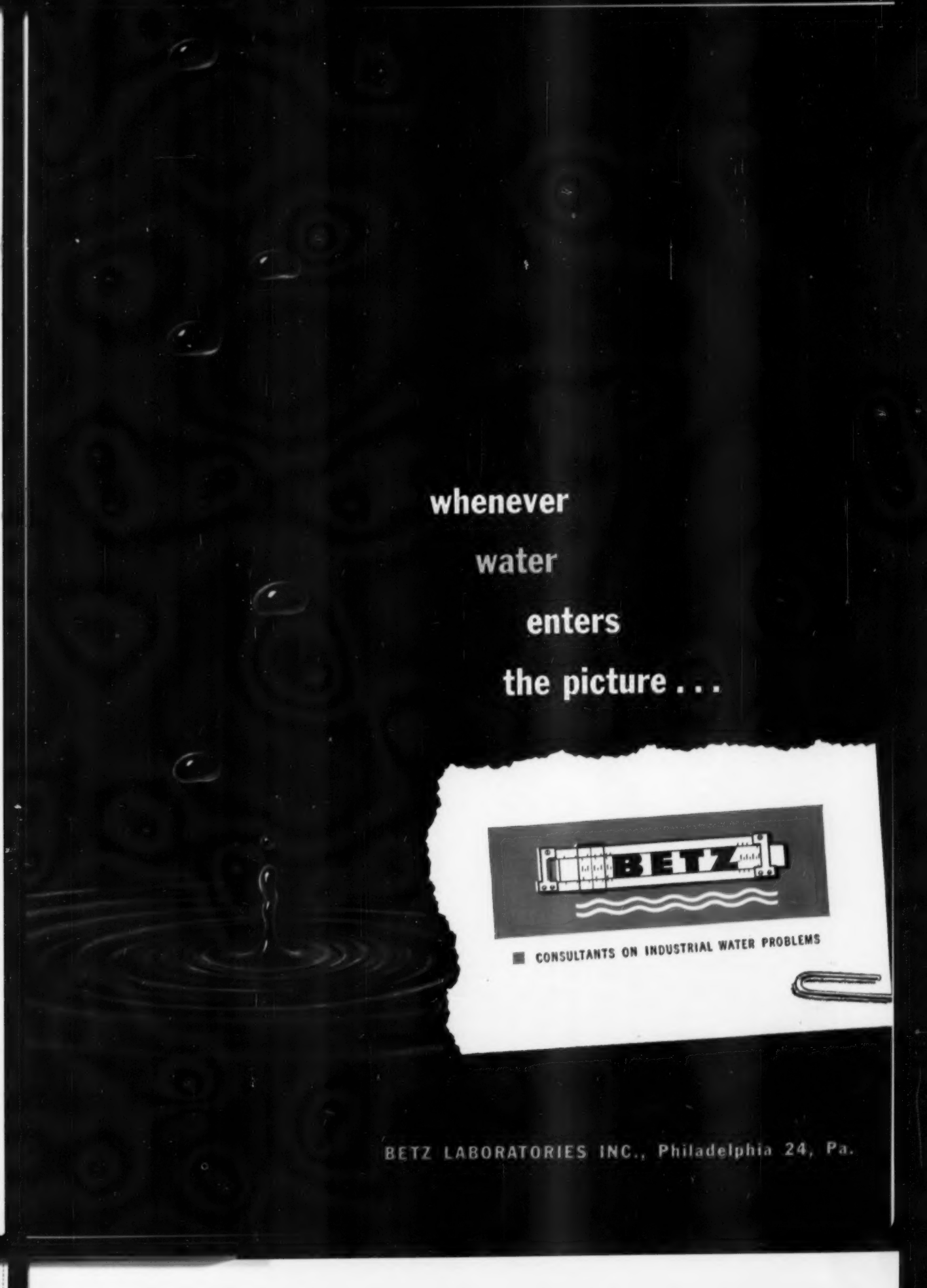
Paramagnetic property of oxygen is likewise employed in the Hays analyzer (Fig. 7). The instrument consists of two cells, the one on the left (top view) being a measuring cell; the one on the right is a comparison cell. Resistors are connected to a bridge measuring circuit.

In the measuring circuit are magnetic pole pieces inserted part way through the cell on each side of the resistor. When a magnet (bottom view) is swung into position at the resistor position in the measuring cell, a magnetic field is created.

Gas enters at the bottom of each cell, flows up around the resistors and down between the cell block walls to the outlet pipe. Without the magnetic field (middle view), the measuring and comparison cells are identical. Gas diffuses into both cells, and cools the heated resistors equally by means of thermal conduction of the gas. The electrically measuring circuit is now zero. In operation, however, the magnet is swung into the cell creating a strong magnetic field in the measuring cell only. Hence, the O_2-bearing gas is attracted into the magnetic field surrounding the heated resistor where it cools the resistor. In so doing, the oxygen loses its magnetism very rapidly (in proportion to the square of its temperature rise). The heated, demagnatized gas is forced out of the magnetic field and upward along the resistor by cooler, more magnetic oxygen bearing gas from below.

The moving gas continues to absorb heat from the resistor and in its downward path along the walls, releases heat to the cell block. A continuous flow of the gas sample is thus magnetically induced, causing a flow rate and cooling effect in definite relation to the magnetism of the gas entering the measuring cell.

The cooling of both the measuring cell and comparison cell resistors causes their electrical resistance to be reduced. The change in resistance of the resistor in the comparison cell is subtracted from the change in resistance in the measuring cell in the bridge circuit. Difference is due to gas oxygen content and this is indicated on the meter. ***END***


whenever
water
enters
the picture . . .
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

Power Engineering handbook

These Two Charts Help Solve Heating and Ventilating Problems

1—How To Measure CO_2 Build-Up
2—How To Measure Heat Loss

By JOHN D. CONSTANCE

IN SOME INSTALLATIONS it is important to know how long it will take for a room to become uninhabitable when there is a negligible amount of air, or no outside air at all, entering the area by any means, natural or mechanical.

Atmosphere containing less than 12 per cent oxygen or more than 5 per cent carbon dioxide by volume is considered dangerous to occupants. The following formula is often used to determine the time for carbon dioxide to build up to 3 per cent with a safety factor:

$$T = 0.04 (V \div P)$$

where T is time to vitiate room air, hours; V is net room volume, cubic feet (gross volume less equipment, etc.); P is number of persons occupying room.

This formula takes into account a minimum condition of activity of occupants and no generation of industrial fumes. The accompanying chart gives the answer to this yardstick quickly.

Example: A room of 50,000 net cubage with an occupancy of 100 employees. How long will it take to render the area uninhabitable, with no outside air entering?

Solution: Follow arrows on chart and read 20 hours. During this time the oxygen content will have been reduced from a nomal of 21 per cent to 17 per cent by volume. It is a good rule to consider that after 5 hours, or ¼ of the calculated time of 20 hours, the air would become stale and affect worker efficiency.

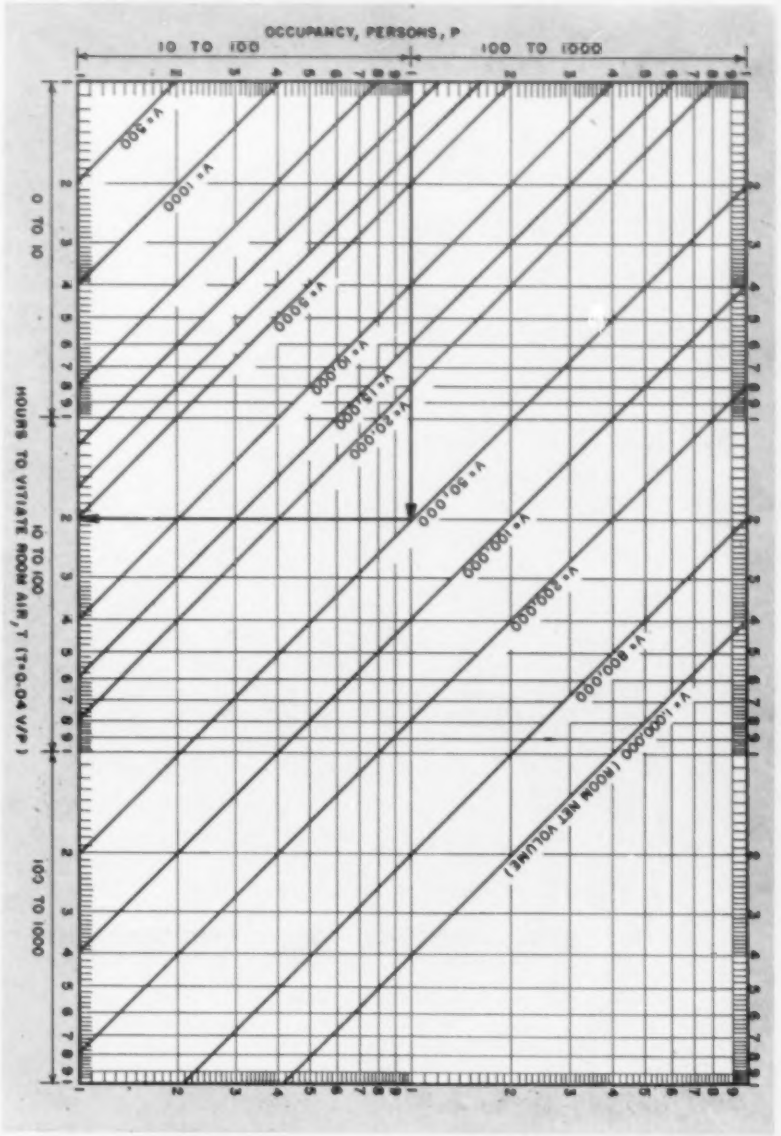
Where reduced air supply is needed for production purposes this graph is a useful guidepost to determine time between airings. A 12-hour time limit is a good figure to use as one that comes close to "uninhabitable" time. It is suggested, however, that a check be made with local and state code requirements.

The chart may be used for storage tanks, and rooms, auditoriums and other places used for large gatherings of people. For determinations other than those covered by chart, use formula.

Chart No. 1 ⟶

QUICK AND PRACTICAL method of checking building heat losses is given in chart presented on page 106. With this graph, factors are obtained for determining the square feet of equivalent direct radiation necessary to compensate for the heat losses through building construction. Doors and windows are figured together as glass (coefficient 1.13). Although the basic curves are for inside conditions of 70 F, a correction factor

fold along this line—outside edges toward you



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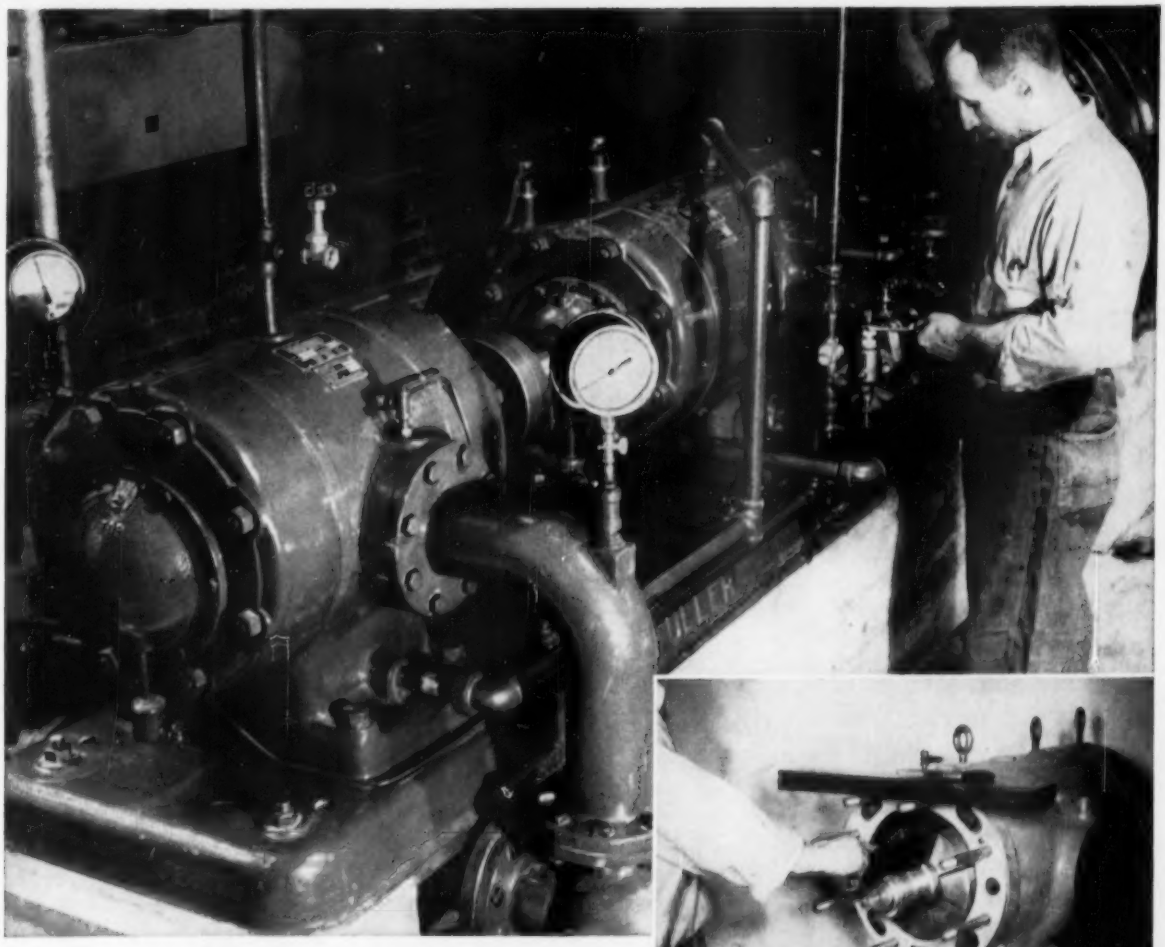

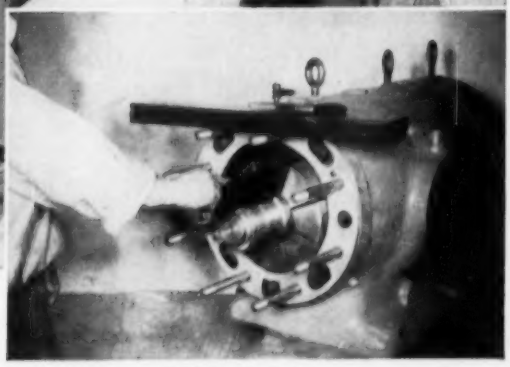

Blade inspection

PERFECT COMBINATION OF MEN AND MACHINES

Providing plant air for varied uses imposes heavy responsibility on both the compressor and its operator to keep production moving.

The simplicity of the Fuller Rotary Compressor principle reduces maintenance to an absolute minimum; by the same token, operator's universal pride in Fuller Rotary performance contributes to longer life of the compressor. Few moving parts and smooth operation limit the operator's work to periodic inspection.

This perfect combination of men and machines is worth investigating, with an eye to economies you, too, can enjoy. Write to Fuller Company, compressor sales department for detailed information.

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PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

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curve is included for other inside conditions.

Example: Given . . . room volume, 3000 cu ft; glass area, 50 sq ft; exposed net wall area, 500 sq ft; outside conditions, −10 F.

Solution: From graph read . . . room volume factor, 162.5.

Edr = 300 ÷ 162.5 = 18.5

Glass factor, 2.7; Edr = 50 ÷ 2.7 = 18.5.

Wall factor, 10.0; Edr = 500 ÷ 10 = 50.

Total Edr is 87. For room temperatures other than 70 F, multiply Edr obtained above by the proper multiplier from the correction curve. These factors are based on good average building construction. Wall coefficient is taken as 0.3. Volume contents factor is based on one air change per hour. See standard texts and the ASHAC Guide. Corrections for wall factors other than those used are in direct proportion. However, the curves as they stand give excellent results. See graph for other conditions.

Chart No. 2 ⟶

System Developed for Marking Grinding Wheels

By PAUL C. ZIEMKE

AS IN THE CASE with many other products in use in general industry, the American Standards Association has done yeoman service in producing an identification system which applies to grinding wheels and other bonded abrasives manufactured in numerous shapes and designed for removing material or developing a high polish or finish plus accurate cross-sectional dimensions. The standard does not apply to grindstones developed from quarried rock. It is a system for marking only. The symbols, presented in a uniform sequence, indicate the most essential characteristics of a grinding wheel.

Sequence of Markings

Markings consist of six parts, which are written in the order of sequence, as follows:

1 Abrasive Type	2 Size	3 Grade	4 Structure	5 Bond Type	6 Manufacturer's Record
A	-36	-L	-5	V	-23

Interpretation of each letter or number is as follows:

1. Abrasive Letters. The letter A is used for aluminum oxide and C for silicon carbide. The manufacturer may designate some particular type in either of these broad classes, by using his own special symbol as an identifying prefix.

2. Grain Size. The grain size commonly used varies from coarse to fine, as indicated by the following numbers: 10, 12, 14, 16, 20, 24, 30, 36, 46, 54, 60, 70, 80, 90, 100, 120, 150, 180 and 220. The following additional sizes are used occasionally: 240, 280, 320, 400, 500 and 600. The manufacturer may add to the regular grain number an additional symbol to indicate a special grain combination.

3. Grade. Grades are indicated by letters of the alphabet from A to Z, in all bonds or processes. Wheel grades range from soft to hard.

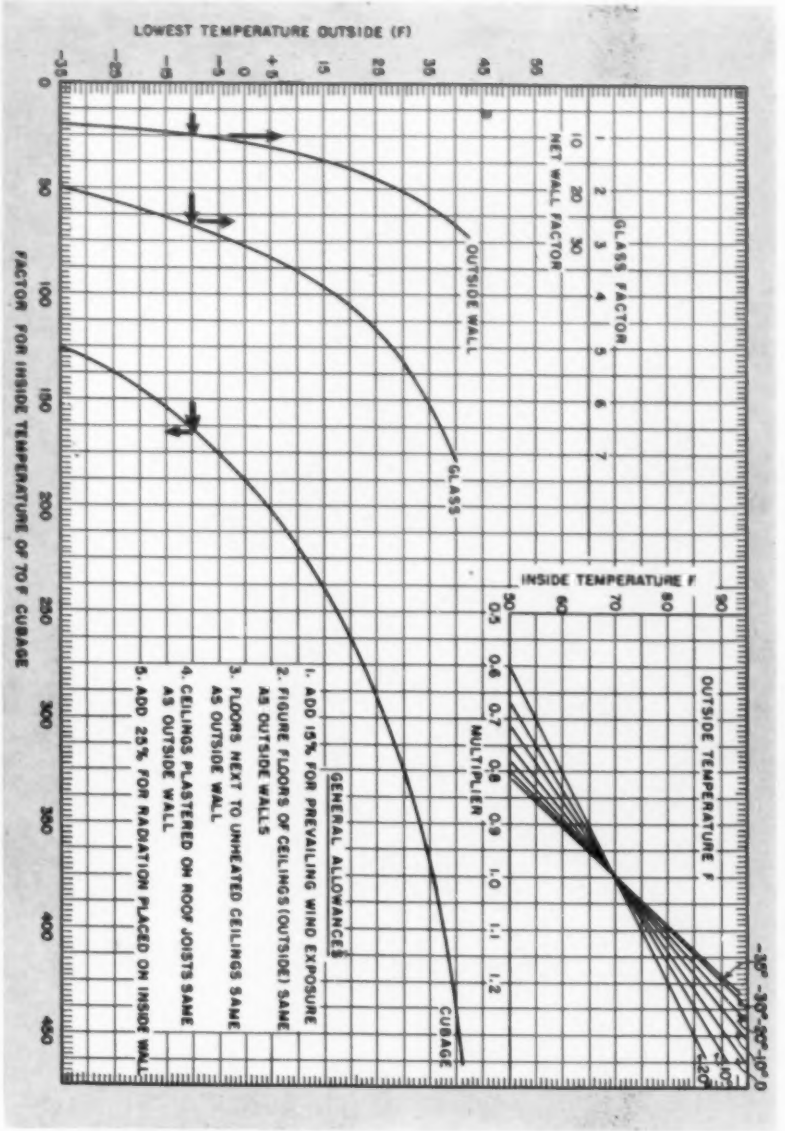
4. Structure. Use of the structure symbol is considered optional. The structure is indicated by Nos. 1 to 15, and occasionally higher as required, with progressively higher numbers indicating less density and wider grain spacing or a more open structure.

5. Bond or Process. Bonds are indicated by the following letters: V, vitrified; S, silicate; E, shellac or elastic; R, rubber; B, resinoid (synthetic resins); O, oxychloride.

6. Manufacturer's Record. The sixth position may be used for manufacturer's private factory marks; this is optional.

Wheels too small in diameter to provide space for applying the full legend may carry grade and grain marking only. The balance of the identification, however, is carried on the shipping carton so that bins and drawers may be properly labeled.

fold along this line—outside edges toward you


LOWEST TEMPERATURE OUTSIDE (F)
FACTOR FOR INSIDE TEMPERATURE OF 70 F CUBAGE
NET WALL FACTOR
GLASS FACTOR
OUTSIDE WALL
GLASS
CUBAGE
INSIDE TEMPERATURE F
OUTSIDE TEMPERATURE F
MULTIPLIER
GENERAL ALLOWANCES
1. ADD 15% FOR PREVAILING WIND EXPOSURE
2. FIGURE FLOORS OF CEILINGS (OUTSIDE) SAME AS OUTSIDE WALLS
3. FLOORS NEXT TO UNHEATED CEILINGS SAME AS OUTSIDE WALL
4. CEILINGS PLASTERED ON ROOF JOISTS SAME AS OUTSIDE WALL
5. ADD 25% FOR RADIATION PLACED ON INSIDE WALL

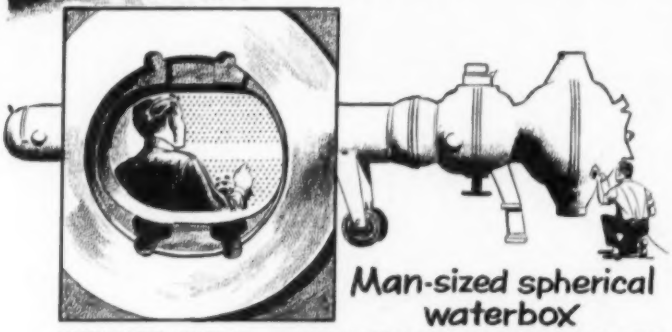
cut along this line

POWER POINTERS

Tucks in turbine with 200 lb. blankets

TO REDUCE HEAT LOSS IN TURBINES OPERATING AT 950°F AND 1250 PSI, ENGINEERS AT A PENNSYLVANIA POWER PLANT USE 200 LB. INSULATING MATS...SECURE THEM WITH MONEL* NICKEL-COPPER ALLOY WIRE. THIS MONEL ALLOY WIRE PROVIDES STRENGTH AND TOUGHNESS; DOESN'T SNAG, RESISTS CORROSION AND CAN OFTEN BE REFASTENED AFTER TURBINE MAINTENANCE

WINDS INTO NEW HELIFLOW UNIT



Man-sized spherical waterbox

FEEDWATER HEATERS — WITH WATER-BOXES BIG ENOUGH TO HOLD A MAN — FEED TWO OF THE LARGEST BOILERS IN THE WORLD. TUBE BUNDLES FOR THE SPHERICAL-HEAD HEATERS — EACH 30 FT. LONG AND 40 IN. IN DIA. — ARE MADE OF MONEL ALLOY. THE HIGH STRENGTH OF MONEL ALLOY IN THE 500°F RANGE PERMITTED THE USE OF RELATIVELY LIGHT (18 GAUGE) TUBING TO HANDLE WATER PRESSURES UP TO 3,000 PSI

SNAIL-SHAPED MONEL BUNDLE BOOSTS HEAT TRANSFER 40%

BY BENDING MONEL NICKEL-COPPER ALLOY TUBING INTO A SNAIL-SHAPED BUNDLE OF PANCAKED COILS, GRAHAM MANUFACTURING CO. PACKS A LOT OF HEAT TRANSFER AREA IN A SMALL SPACE. THE HELIFLOW DESIGN ACTUALLY BOOSTS HEAT TRANSFER AS MUCH AS 40% OVER CONVENTIONAL UNITS OF THE SAME VOLUME. MONEL ALLOY TUBE BUNDLE ABSORBS EXPANSION STRESSES AND RESISTS CORROSION. IN SOME UNITS, THESE MONEL ALLOY COILS HANDLE UP TO 15,000 PSI!

NEED HELP ON A METAL PROBLEM?

TWO HEADS ARE BETTER THAN ONE. WHY NOT SHARE YOUR METAL PROBLEM WITH INCO. AS A STARTER — SEND FOR "ENGINEERING PROPERTIES OF MONEL AND 'K' MONEL". ONE OR BOTH OF THESE TWO NICKEL-CONTAINING ALLOYS MAY BE JUST WHAT YOU'RE LOOKING FOR.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

*Registered Trademark

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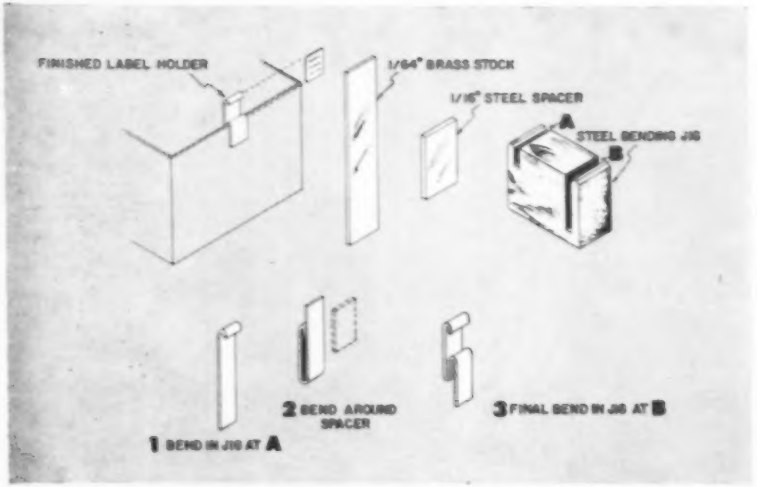

Easily-made label holders of spring brass can be produced quickly by use of simple fixtures shown here

Make Your Own Label Holders

By C. H. WILLEY

WHEN YOU need some easily detachable card or label holders, you can make them quickly to suit your own exact size requirements; no need to shop around and search through catalogs to find something *almost* right.

Determine how many holders you will need, then obtain sufficient ¼-in. thick spring-hard brass in strip form. We used stock 1⅛-in. wide for our purpose — but other widths are available.

Make a bending jig, as shown in the accompanying drawing, by hack-sawing two slots in a steel block. Cut the slots to the depths necessary for the size holder you are making, then break the edges with a file to provide a radius for the bends.

Cut a piece of 1/16-in. steel for a spacer block — dimensions of this piece to be as necessary to form bend No. 2 in the drawing.

Form the first bend in the shallow slot of the bending jig; next, put the spacer in position and make the second bend. Remove the spacer and make the final bend with the deeper slot in the bending jig. After the bends have been made, pinch the loops in a vise so that they tend to close up; this will give the finished holders a grip when clipped on thin steel or cardboard.

When pinching the bends in the vise, be careful not to apply so much pressure that the bends crack. If many holders are to be made up, it is wise to fashion a vise stop of metal that can hang between the jaws and prevent them from closing more than is required to give the bends a good grip.

A large number of label holders can be made by this method in a surprisingly short time.

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue.—Editors.

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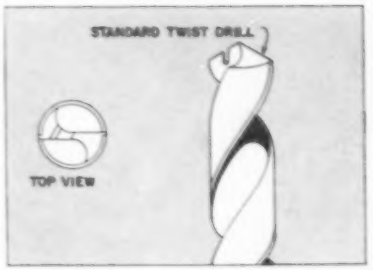


Slot in point of drill should be angled at a little less than 90 deg with the cutting edge

New Twist on Stone with A Slotted Twist Drill

By PAUL C. ZIEMKE

MECHANICS REQUIRED to develop large numbers of holes in marble, soapstone and alberene-stone soon learn that the ordinary steel twist drill has definite limitations, especially if the work is performed with hand equipment such as the ratchet drill.

The dulling action of the cutting edge can be prevented to a large degree by a little trick that works wonders in lightening the load for the hand ratchet man, or even for the lucky fellow with the slow-speed electric power tool.

This special drill bit is developed by grinding or filing (a good abrasive cut-off wheel will do it) a slot in the point of the drill, as indicated in the sketch. The slot will vary in depth according to the size of the drill, so that 1/8 to ¼ in. is about right for the average bit. It should be at an angle of a little less than 90 deg with the cutting edge.

If carefully done, especially as to the amount of pressure applied, and if the cuttings are cleared with compressed air or water stream, a surprising number of holes can be drilled with little dulling action.

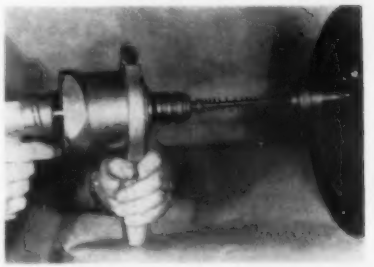
Editor's Note: for readers who have enough masonry drilling work to use carbide-tipped drills, a series of four articles which POWER ENGINEERING published in 1954 should be useful. These articles were written by Bernard L. Chapin and Ralph N. Alper of the New England Carbide Tool Co., and appeared in the issues of June, July, August and September, 1954.

Here's a Good Idea for Tube Expanding

WHEN ROLLING a number of condenser or evaporator tubes, the operator has to push the expander cage forward on the mandrel each time he finishes expanding a tube. This time spent in repositioning the cage is entirely non-productive, and when 1,000 to 5,000 tubes have to be expanded, the number of wasted motions will add up to a sizeable amount of lost time and a tired operator.

To eliminate this wasted effort and time, insert a light coil spring between the ball-bearing collar of the expander and the head of the mandrel. The spring will cause the expander cage to come forward automatically when the expander is removed from the tube, so there is no need for repositioning by the operator, according to the engineers of Thomas C. Wilson, Inc.

Since expanders used in condenser and evaporator tube rolling have nuts on the head of the mandrel, the spring will not cause the assembly to come apart. However, watch that the pile-up or compressed dimension of the spring is not so great that it restricts the required forward motion of the mandrel. On the majority of these jobs, there is usually room for such a spring.



Spring on tube expander cuts time and effort during condenser- or evaporator-tube rolling

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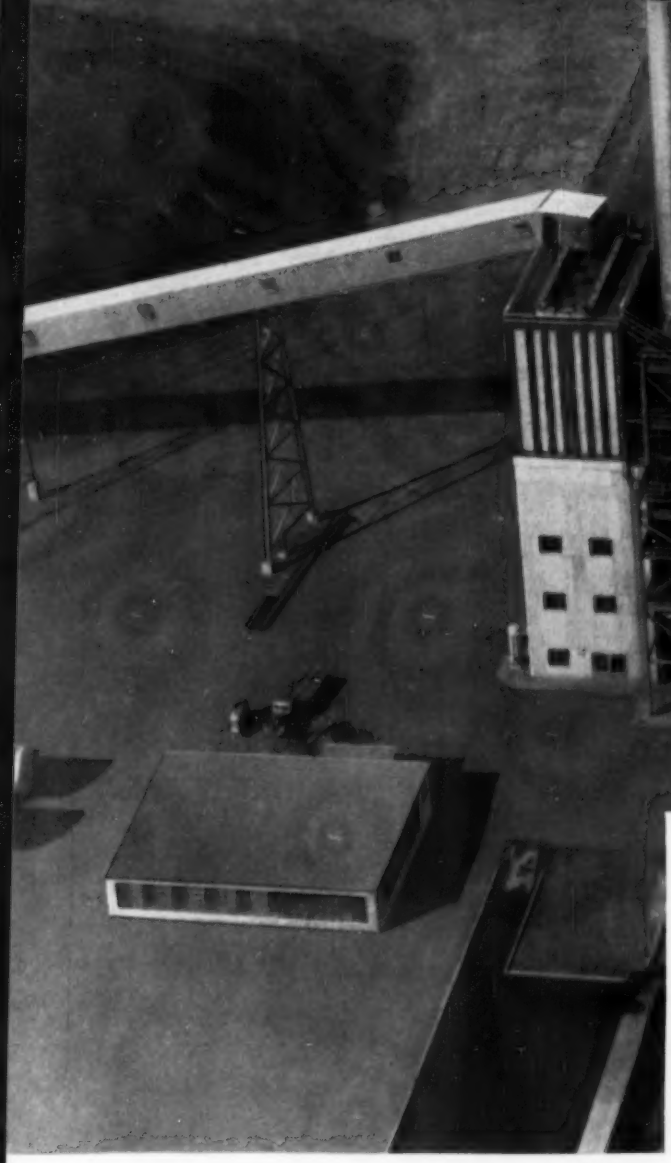


Greenwood Mills ups boiler efficiency to 90% burning coal the modern way

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

When its original power plant could not keep up with growing steam demand, Greenwood Mills, Greenwood, S. C., studied the problem and decided to replace the old facilities.

Greenwood's engineering and construction departments, working with Consulting Engineer Frank Hill of Greenville, designed and built a completely modern power plant. It features a pressurized 300,000 lb./hr. boiler equipped with two cyclone furnaces burning ¼" x 0" coal. Automatic throughout—from coal conveyors to pneumatic combustion control to hydraulic ash handling—the system is manned by a minimum of operators. Burning coal the modern way has resulted in a trouble-free boiler plant operating at a combustion efficiency of 90% or better.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

BITUMINOUS COAL INSTITUTE
Southern Building • Washington 5, D. C.

For more data circle 551 on Post Card

How To Inspect Power Transformers

Transformers require less care and attention than almost any other electrical power apparatus. However, a regular program of inspection should be established and rigidly carried out

POWER TRANSFORMERS should be regularly inspected because a failure is usually costly from the standpoint of interrupted service as well as repairs.

Large power transformers should be inspected from time to time to see that the oil is at the proper level and a sample of oil should be drawn from the bottom of the tank. The dielectric strength should be tested. Oil should not be permitted to go below 20,000 v with 0.100 gap in standard oil test cup.

The whole procedure for inspecting is clearly outlined by Westinghouse in a recent booklet, from which these paragraphs are taken.

Checking Oil

The oil should be checked for discoloration and for signs of sludge or carbon. If the oil shows appreciable sludge or if the dielectric strength is below 22,000 v in the standard test, the oil should be filtered or centrifuged and perhaps replaced with new oil. If the sludge is bad, then the oil should be removed. The core, coils, terminal boards, etc. should then be washed down with clean hot oil under pressure. This can be done by using the filter press hose and filter press pump pressure. Badly sludged oil should not be returned to the tank without retreatment, since oil that has once sludged then sludges more easily unless reconditioned. If sludging persists a careful investigation should be made to discover the cause.

If water is found in the oil, a careful check should be made of all bushings, gaskets and tank openings to discover the source of the water. Defective gaskets, weld leaks, etc., should be corrected immediately. Water cooling coils, if present, should be checked and pressure tested. Cooling coil leads must be thoroughly insulated to prevent possible condensation.

Water cooling coils in water-cooled transformers should be checked periodically for possible obstructions. If the rate of flow has diminished, the cause should be discovered and remedied.

Inspection

All connections, both inside and outside of the transformer, should be inspected occasionally to see that they are tight and to see that there is no discoloration, which would indicate "hot" connections. Any connections that show signs of having been hot should be thoroughly cleaned and bolted together tightly. Any tap changer contacts that have been hot should be cleaned and adjusted, or replaced. Be sure the tap changers are all on same position. A tap changer left between points may cause a transformer failure.

Before installing single phase power transformers, they should be thoroughly checked for voltage ratio, impedance and polarity similar to that method described for distribution transformers. In the event of a failure of one transformer in a bank of three transformers connected in delta-delta, it is possible to connect the remaining two transformers in open delta and operate them at 58 per cent of the total capacity of the three transformers.

Frequency of Inspection

As to the regularity of inspections on large transformers, different companies may have different rules. Some companies make it a rule to inspect their large transformers at least once a year. They check the ground resistance and also check the circulating current and all of the plant connections at this inspection. They give the oil a complete test. If necessary, the oil is filtered. They also make a "Megger" test of the windings and keep a record chart from year to year of the values.

"Megger" Readings

Opinion varies among operators as to the minimum Megger value allowable before removing a transformer from service. One operator uses the data shown in the table:

fold along this line—outside edges toward you

Voltage of Winding	20 C.	30 C.	40 C.	50 C.	60 C.
66 KV. and above	1200	600	300	150	75
22 to 44 KV.	1000	500	250	125	65
6.6 to 19 KV.	800	400	200	100	50
Below 6.6 KV.	400	200	100	50	25

Table showing minimum safe insulation resistance in megohms at different temperatures—winding to ground

It is very important that all openings in the case be tightly closed before putting a transformer into operation. This is necessary whether the transformer is for indoor or outdoor operation. Careful work in preparing and placing all gaskets and in uniform tightening of all nuts and bolts is required.

Gaskets

The best insurance against leaks after opening a transformer is to use a new gasket properly cemented to thoroughly cleaned surfaces.

Gaskets for liquid-filled transformers are cut from either cork-neoprene (corprene) or cork-Buna-N (Cortite). Both are suitable for sealing oil, water or gas but only Cortite is suitable for sealing inerteen. Corprene is dissolved by inerteen.

Corprene should be compressed to from 60 to 70 per cent of its original thickness depending on the grade of material. Cortite should be compressed to 50 per cent.

Gaskets are of both retained and non-retained types. Retained gaskets should be approximately 80 per cent of the recess width. Non-retained gaskets should be the full flange width with holes on the centerline.

For many years it has been quite a problem to get a good job of installing gaskets on bushings, manhole and main covers, etc., on outdoor transformers, but with the development of new cements, a reliable job can be done.

Water Cooling Coils

If water-cooled transformers show excessive heating, they should be checked for overload and the oil should be examined for sludge. If the load is all right, then the heating may be due to the water cooling coil becoming partially stopped up and reducing the water flow required. There may also be a heavy scale on the outside of the cooling coil. This can be cleaned by several methods.

(1) Using hydrochloric acid solution: Scale and sediment can be removed from a cooling coil without removing the coil from the tank. Both inlet and outlet pipes should be disconnected from the water system and temporarily piped to a point a number of feet away from the transformer, where the coil can be filled and emptied safely.

All water should be blown or siphoned from the cooling coils which are then filled with a solution of hydrochloric (muriatic) acid, specific gravity 1.10. (Equal parts of commercially pure concentrated hydrochloric acid and water will give this specific gravity.)

It may be found necessary to force this solution into the cooling coils. When this is done, one end of the coil should be partially restricted, so that the solution will not be wasted when the coil is full. After the solution has stood in the coil about an hour, the coil should be flushed out thoroughly with clean water. If all the scale is not removed the first time, the operation should be repeated until the coil is clean, using new solution each time. The number of times it is necessary to repeat the process will depend on condition of the coil though one or two fillings are usually sufficient.

As the chemical action which takes place may be violent and often forces acid, sediment, etc., from both ends of coil, it is well, to leave ends partially open to prevent abnormal pressure.

(2) Using a solution of caustic soda and blowing it through the coils.

(3) Using an electric vibrating machine to loosen scale and finish with hydrochloric acid.

(4) Using hot sodium cyanide (6 oz. to one gallon water). With this method, caution should be used in handling the sodium cyanide as it is very poisonous.

There are three ways: (1) Using an electrically rotated wire brush.

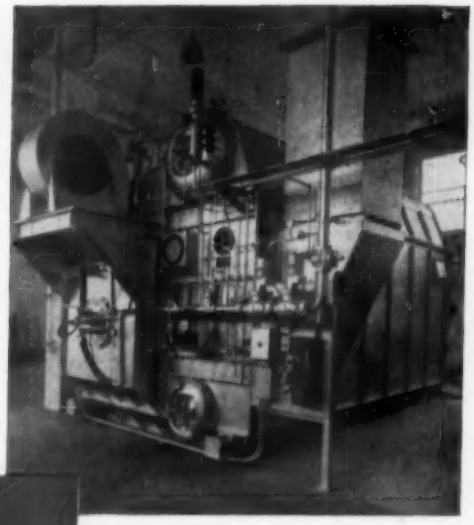
(2) Using a solution of caustic soda and steam.

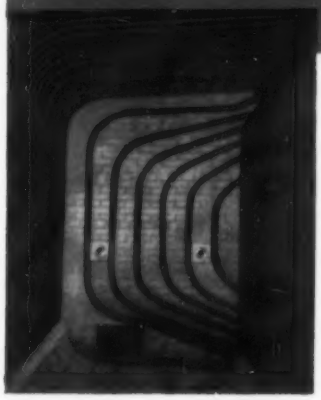
(3) Using a hand wire brush.

Immediately after all cleaning is done with acid or caustic, the coils should be thoroughly rinsed with clean water.

cut along this line

packaged power for limited space requirements . . .





KEELER

Type D-K

a comparatively wide and short boiler incorporating the proven efficiency and economy of Keeler Water Tube Steam Generators in a compact, low cost unit

Where boiler room space is definitely limited, the KEELER TYPE D-K Water Tube Package Steam Generator is the answer to your problem! It's a comparatively wide and short boiler for use where long boilers of other types cannot be accommodated.

KEELER TYPE D-K Package Boilers are made in oil or gas fired units with capacities from 8000 to 45000-lbs. of steam per hour—standard design pressures of 200 psi and maximum design pressures of 500 psi. The furnace sides, roof and floor, as well as front and rear walls, are water cooled and insulated. The complete "package", ready for quick hook-up and operation, includes all burning equipment, controls, safety devices and accessories.

For a low first cost, low operating cost outfit, you'll want the full particulars on this compact Package Power Plant! Write or phone . . . there's a KEELER representative at your service in your locality.

Write For Bulletins

No. DK-1: Type DK Package Boilers
No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
No. MK-1: Type MK Boilers

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— ESTABLISHED 1864 —

E. KEELER CO.

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— OFFICES IN PRINCIPAL CITIES —

KEELER WATER TUBE Boilers

For more data circle 552 on Post Card

Which of these characteristics are essentials on your Remote Control Jobs?

• Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of ACCO TRU-LAY PUSH-PULL *flexible* CONTROLS that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our **DATA FILE** available for your further study.

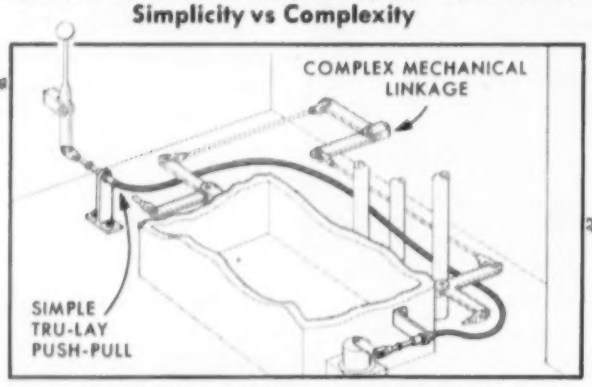
ACCURACY is inherent in the basic design, and in the standards of quality and precise dimension that control the manufacture of TRU-LAY PUSH-PULL CONTROLS. These are precision products, not gadgets.

VERSATILITY of this fine remote control can best be illustrated by citing some of the jobs it handles well . . . **HOT** jobs on jets and industrial furnaces . . . **COLD** jobs down to —70°F . . . **WET** jobs (the conduit can be completely immersed) . . . **DIRTY** jobs . . . **ABRASIVE** jobs . . . **CORROSIVE** jobs . . . **HEAVY, TOUGH** jobs up to 1,000 lbs. input . . . **LIGHT DUTY** jobs . . . **REMOTE** jobs 150 feet or more from the control point. These units are frequently and successfully used in conjunction with electric, hydraulic and air controls . . . are thoroughly effective under almost any operating condition.

"Solid as a rod but *flexible as a* wire rope" aptly describes TRU-LAY PUSH-PULL CONTROLS. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . protects delicate instruments . . . it permits ease of handling and shipping even when assemblies are 100 or 150 feet long . . . it avoids the risk of damage always present with solid tubular controls that must be preformed to position . . . and flexibility greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Advantages of Tru-Lay Push-Pull flexibility and simplicity are pictured below

Simplicity vs Complexity



Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased back-lash, lost accuracy and vibration rattles.

• Whether your interest is in a single application of this versatile PUSH-PULL CONTROL, or in its inclusion as a component of the product you manufacture, the six booklets and bulletins in this **DATA FILE** will answer your further questions, and will also provide you with the means of defining to us the applications you may be interested in.

Write for a copy without obligation

ACCO

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

601M Stephenson Bldg., Detroit 2
2216M South Garfield Ave., Los Angeles 22 • 929M Connecticut Ave., Bridgeport 2, Conn.

Push-Pull DATA FILE

For more data circle 553 on Post Card

APPR at Fort Belvoir

continued from page 81

to transport and store bulky conventional fuel. The APPR is designed to operate a full year and a half on a single charge of nuclear fuel, which is smaller than a barrel and weighs only a few hundred pounds. Over the same period a comparable conventional plant would consume some 60,000 barrels of fuel oil.

Investigations revealed that at some remote and inaccessible sites the cost of generating power was 5 to 10 times greater than at large central stations in the U. S.

In 1953, upon request of the Corps of Engineers, the Operations Research Office (ORO) of Johns Hopkins University performed a detailed analysis of the feasibility of the preliminary design of APPR and compared it with the cost of building and operating a conventional plant. Fig. 6 shows a typical set of curves of the type used in the ORO study. The curves compare the total cumulative dollar outlay, over a period of years of plant operation, for a nuclear and a conventional plant.

This curve shows that a nuclear plant gives increasing savings after 12 years of operation compared to the total outlay for a conventional plant. The vertical rise in cost for the nuclear plant indicates nuclear fuel reloading which in this analysis would occur every five years. If the comparison were made at certain other sites where the fuel cost is greater, the nuclear plant outlay would be less than conventional in a shorter period of operation.

As a result of these studies, a military requirement was established by the Joint Chiefs of Staff for the development of nuclear power plants for use in remote and relatively inaccessible locations. The APPR is the first such plant to be completed. Its operation will be regarded with great interest, not only by the military, but by civilian power engineers as well, because, as indicated at the beginning of this article the size of this plant is such that it has potential use in industry.

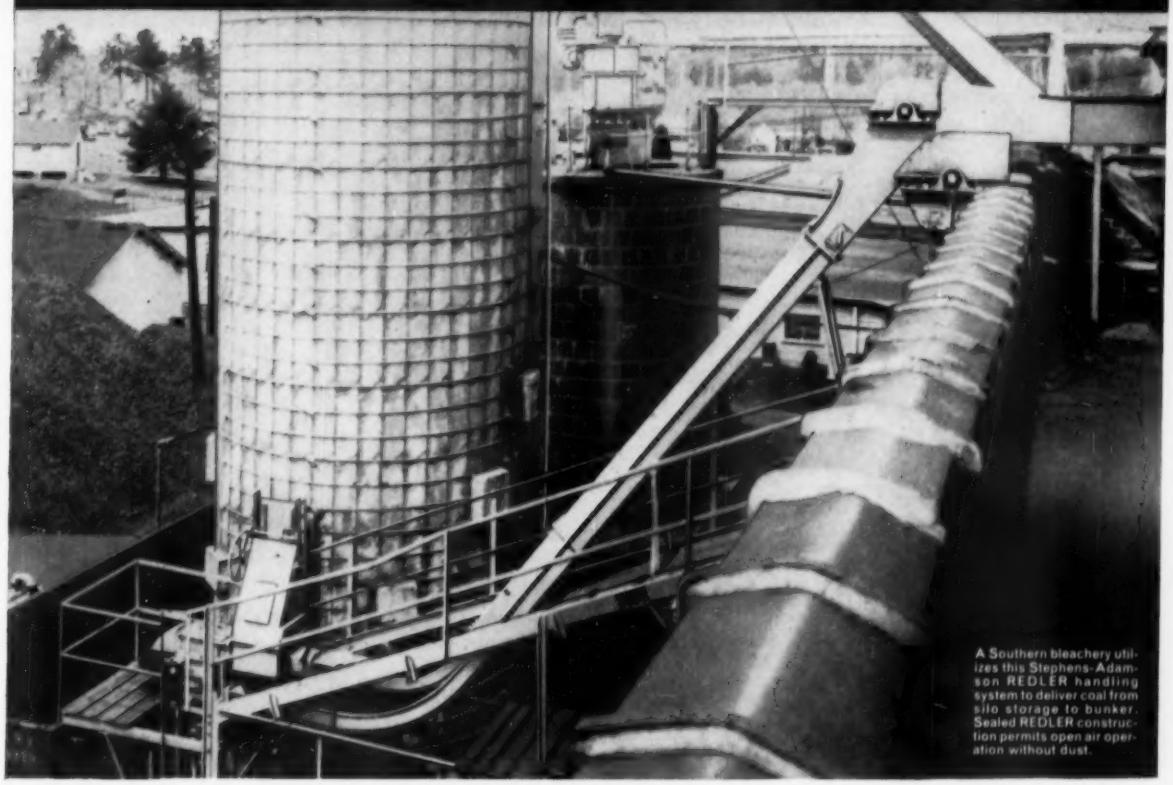
Gas Turbines

continued from page 85

Exhaust from a 5000-kw simple-cycle gas turbine can generate 35,000 to 40,000 lb of process steam per hour in a simple, exhaust-heat-recovery boiler. With unfired exhaust-heat-recovery boilers, a ratio of 6 to 8½ pounds of steam per kilowatt-hour is a reasonable steaming capacity to assume for boilers recovering heat from the exhaust of General Electric simple-cycle gas turbines.

If a boiler is to be installed to

STEPHENS-ADAMSON



A Southern bleachery utilizes this Stephens-Adamson REDLER handling system to deliver coal from silo storage to bunker. Sealed REDLER construction permits open air operation without dust.

king coal will take some handling for years to come

Energy from atoms is still in the future. Coal will reign for some time as king fuel for steam power generation. So long as coal retains this importance, handling techniques will continue to be a major concern for the power engineer.

In providing the ways to keep coal handling costs where they belong, STEPHENS-ADAMSON has, over many years, developed a complete and effective line of conveying equipment. S-A engineers use these products strategically in devising the best system for coal distribution in or outside of the power plant.

To the plant operator, an S-A conveying system means continuous, uninterrupted coal flow with minimum supervision, maintenance, or replacement. Its his ally for economical operation.

The STEPHENS-ADAMSON engineer in your district will provide a free survey of your coal handling requirements.

STEPHENS-ADAMSON builds a variety of crusher equipment. This double rotor Knittel crusher handles damp, sticky coal without plugging, reducing large lumps to 1½" to ¼" size. Furnished with or without tramp iron release fingers for removal of uncrushable materials.

Amalgamated Sugar Co., Nyssa, Oregon, moves coal to combustion with an S-A system which includes this double leg 23' REDLER conveyor. The REDLER receives coal from a long belt conveyor. In the first seasons' operation, this system delivered almost 44,000 tons of coal in 149 days.

S-A manufactures a wide range of material handling products in three complete plants in U. S. and Canada.

Belt Conveyors
Belt, Pan & Plate Feeders
Ship Loading Boom Conveyors
Stacking Conveyors
Storage & Reclaiming Systems
"Natural Frequency" Vibrating Conveyors
REDLER Conveyor-Elevators
ZIPPER Conveyor-Elevators
Conveyor Belt Cleaners
Headshaft Holdbacks
Grizzlies & Screens
Centrifugal Pilers
Bin Gates & Tunnel Gates
Car Pullers & Spotters
Bucket Elevators
Skip Hoists
SEALMASTER Ball Bearing Units

• *Write for a bulletin on any of the above products.*

STEPHENS-ADAMSON MFG. CO.
86 RIDGEWAY AVENUE, AURORA, ILLINOIS
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ENGINEERS • DESIGNERS • FABRICATORS

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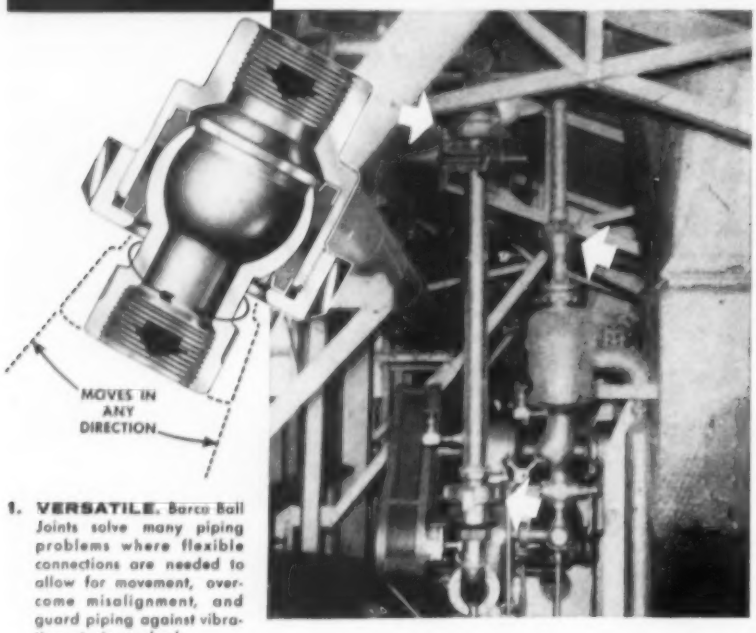
BARCO *Flexible*

BALL JOINTS



1. **VERSATILE.** Barco Ball Joints solve many piping problems where flexible connections are needed to allow for movement, overcome misalignment, and guard piping against vibration, strain or shock.
2. **MAXIMUM FLEXIBILITY.** Up to 40° side flexibility with 360° rotating movement.
3. **MANY STYLES AVAILABLE.** Angle or straight; threaded or flanged connections. For pressures to 4500 psi; temperatures to 1000° F. 15 different sizes, ¼" to 12".
4. **CHOICE OF MATERIALS.** Built to meet service requirements for steam, oil, gasoline, water, chemicals, and other fluids.
5. **ENGINEERING RECOMMENDATIONS.** Barco will be glad to send you complete information—ASK FOR BULLETIN No. 2158.

Solve STEAM Line Connection Problem

IN this Texas power plant (above), Barco Ball Joints were used to replace steam hose which burst when used for connections from overhead header to draft fan turbines located on the tops of four boilers. These connections must handle 467° F. steam at 250 psi and allow movement to take up wear on the turbine-to-fan belt drive.

The problem was solved permanently by using steel pipe made *flexible* with steel Barco Ball Joints equipped with standard No. 11 gaskets — two 1" joints on inlet line to each turbine and two 2½" joints in each exhaust line (see arrows). THESE JOINTS HAVE NOW BEEN IN SERVICE SEVERAL YEARS WITH NO ATTENTION AND NO FAILURES.

For recommendations and information, see your local Barco representative or write.

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.

5476 Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

In Canada: The Holden Co., Ltd., Montreal

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Gas Turbines

continued from page 112

recover sensible heat in the turbine exhaust, the added flexibility and steaming capacity available by making the boiler suitable for fuel firing should not be overlooked. Because of the excess air available in the gas turbine cycle, exhaust from the gas turbine contains approximately 17 per cent oxygen compared to 21 per cent for free air. This exhaust can be utilized as combustion air for additional fuel firing in a supplementary-fuel-fired boiler when more steam is required than can be generated from the hot exhaust alone.

A fuel-fired exhaust-heat-recovery boiler is selected when it is desired to make maximum use of the oxygen available in the gas turbine exhaust. This type of boiler is similar to the supplementary-fired exhaust-heat-recovery boiler indicated in Fig. 2, except the fuel burners and boiler construction will be essentially the same as in a normal fuel-fired boiler. Somewhat less expensive construction can be used in supplementary-fired boilers if maximum gas temperatures do not exceed 1500 to 1800 F.

For the unfired boiler, practical limitation on maximum steam pressure is approximately 200 to 250 psig saturated if operation over a wide range of turbine loads at constant speed is anticipated. Somewhat higher steam conditions would be practical where turbine speed is reduced or when a two-shaft gas turbine is considered.

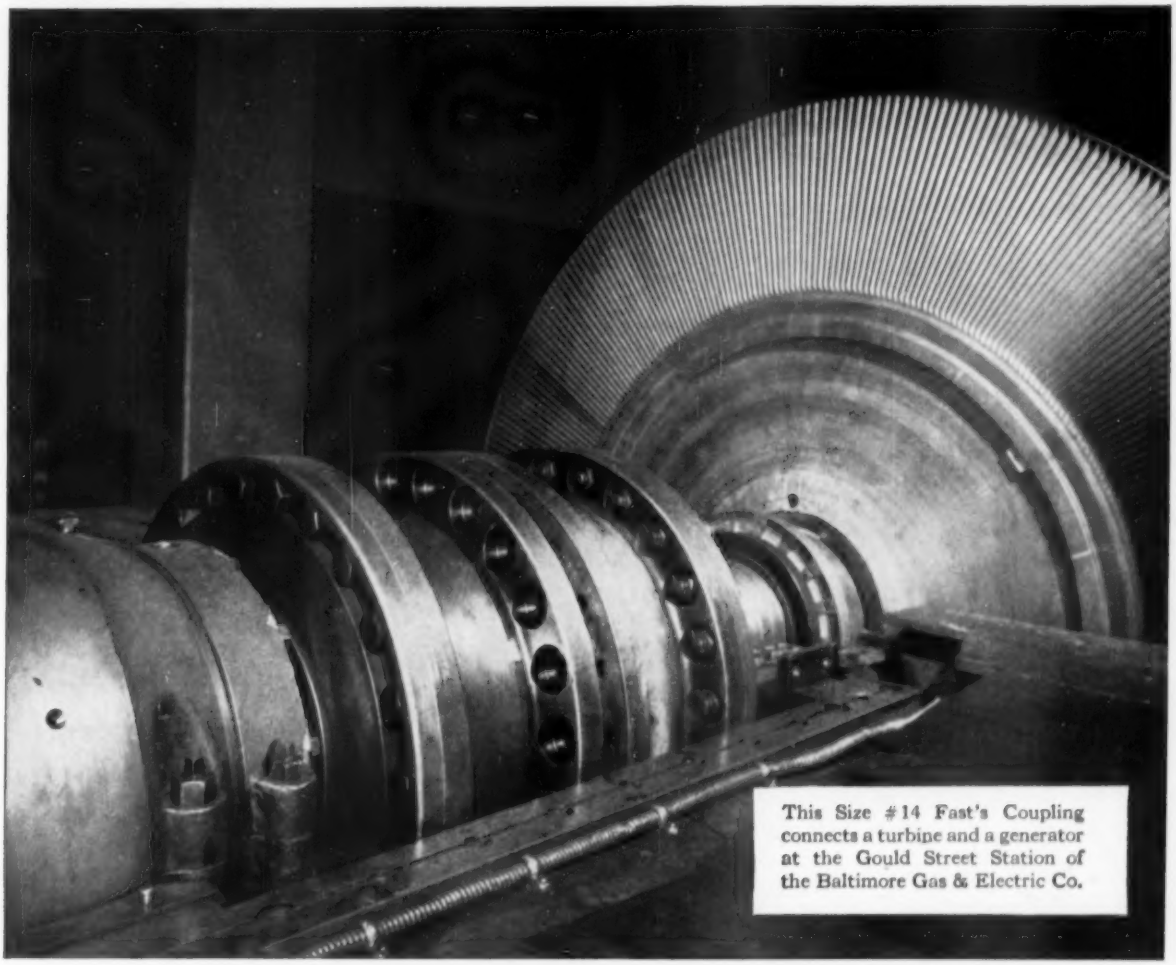
By the addition of fuel firing, a boiler for any steam condition normally used in industrial plants can be selected as required for most economical over-all plant operation. In addition, controls can act to vary automatically the amount of fuel fired in the boiler to cover a range of steam flow requirements independent of the load on the gas turbine or the ambient temperature.

Btu Available

Based on GE simple-gas turbines, the data tabulated in the table will permit preliminary planning for additional power and steam facilities using gas turbines with exhaust or fuel-fired exhaust-heat-recovery boilers. This data is based on a boiler stack temperature of 400 F when firing natural gas in the gas turbine and in the boiler.

In the table, *Heat from Fuel Added in Steam* is simply the ratio of lower to higher heating value of the fuel. This simplified allocation of heat is made possible by assuming that the boiler used for the *Full Boiler Firing* has sufficient additional surface over the boiler used for *No Boiler Firing* to result in a constant 400 F stack temperature for either boiler at rated operating condition.

The steam flows shown in Fig. 3 are based on data from the table and



This Size #14 Fast's Coupling connects a turbine and a generator at the Gould Street Station of the Baltimore Gas & Electric Co.

This Fast's Coupling runs smooth after 29 years of service!

This Size #14 Fast's Coupling has never had a major part replaced since its installation on January 4, 1927.

The Baltimore Gas & Electric Company has provided excellent care and inspection . . . examining the coupling during each routine overhaul of the turbine and generator. The last inspection (shown above) was during the fall of 1955.

Unique design permits Fast's Couplings to compensate for both offset and angular misalignment of shafts and eliminates the wear of metal upon metal. It provides positive lubrication which forms a film on load-carrying surfaces of the teeth. Metal bearing rings located at the mid-axis of the teeth keep out dirt, grit and moisture—keep lubricant in. Fast's metal-to-metal seal protects the lubricant against pollution.

A Koppers engineer can show you how Fast's Couplings will give you extra years of service and reduce down-time. For more details, write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 3706 Scott Street, Baltimore 3, Maryland.

Koppers Company, Inc.
Metal Products Division
Baltimore 3, Maryland

Engineered **Products**
Sold With ***Service***

KOPPERS

THE ORIGINAL
FAST'S Couplings

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if

you have any of these troubles:

1. **SCALE, CORROSION, or FOAMING** *in your boiler operation.*
2. **RUST and CORROSION** *in your steam and condensate lines.*
3. * **SCALE, CORROSION, or ALGAE GROWTH** *in your cooling or condenser water system.*
4. **CORROSION or SCALE** *in your hot or cold water tank and lines.*
5. **RUST and CORROSION** *in your brine or sweet water system.*
6. **SCALE** *in pumps, water jackets, compressors, coils, lines, or equipment.*
7. **SLUDGE and MOISTURE** *in your fuel oil supply.*
8. **SOOT DEPOSITS** *in your furnace combustion areas.*

then . . . let WESTERN prove to you how a specific treatment applied to your specific problem can restore and maintain efficiency and economy in your use of water, steam and fuel. Check the number or numbers of the problems you have in the coupon below. Get full information.

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. . . Western's Cooling Water Treatment has been technically formulated and proved in use to prevent scale deposits, corrosion and algae growth in cooling towers, engine jackets, condensers, coils and piping.

Over 65 Years of Know-How in the Chemical Treatment of Water

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Gas Turbines

continued from page 114

show the large additional steaming capacity that is available by the addition of fuel firing in the boilers to utilize oxygen in the turbine exhaust. The actual boiler flow capacity will depend on the plant requirements. The total surface in the steam generating unit, and, therefore, the over-all heat recovery, will depend on such things as fuel cost, rate of fixed charges, etc.

In the case of the cycle in which the gas-turbine exhaust is utilized in an exhaust-heat-recovery boiler, the steam generated may be used for either process or power purposes. Experience indicates that the gas turbine, with an exhaust temperature of 840 F, can generate steam economically up to a temperature of about 750 F in an exhaust-heat-recovery boiler. Some of the uses to which such installations have been put here and abroad are: steam for chemical processes, steam for heating residual fuel oil for boilers, hot water or steam for space heating, blast-furnace gas preheating, etc.

Using gas-turbine exhaust as preheated combustion air in a steam boiler is probably the most attractive of these three methods of combining the gas turbine with new steam plants. A number of benefits are obtained when the gas turbine is used as a topper on the steam plant: A major part of the energy in the gas-turbine exhaust gas is recovered in the steam boiler; higher pre-heat temperatures promote combustion in the boiler; plant capacity can be increased when the boiler is the limiting factor; higher temperature of the oxygen supply to the boiler decreases fuel requirements; heat rate in new or existing plants can be improved significantly.

Gas turbines have all sorts of possibilities; look over your plant or processes for ways to utilize them to advantage.

"Been in the Power Department for years and years"

ALL-PURPOSE SAFETY VALVE

REDUCES YOUR INVESTMENT FOR STEAM GENERATOR PROTECTION...

THE TYPE 1511 CONSOLIDATED SAFETY VALVE is today's best value in all-purpose safety valves for steam generator service. It is precision-built yet costs less than other valves for similar applications. Its high efficiency reduces the number of safety valves needed per boiler—saves maintenance time and costs. Compactness of design reduces the amount of space and head room required for installation and to operate the lifting lever.

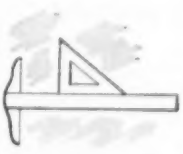
There is no need to carry a large inventory of Consolidated Safety Valves. Stocks of valves are maintained at convenient warehouses where they can also be set to your specific requirements before delivery.

Since the Type 1511 was first introduced, its functional perfection and economy have unqualified acceptance from the power industry. Write for complete details about this efficient valve. Ask for Bulletin 730.

Type 1511 Consolidated Cast Iron Safety Valve. Sizes: 1½" thru 6". Full range of orificies. *Pressures:* Up to 250 psi. *Temperatures:* Up to 450° F.

COMPACTNESS
saves space and headroom and permits the use of smaller, more economical discharge piping.

LOWERS THE COST
per pound of steam discharged because maximum capacity is designed into minimum flange size. The size and/or number of safety valves per boiler are reduced.



ALIGNMENT IS BETTER
blowdown adjustment is easier and operation is finer because the valve has an integral double-guided combination adjustment ring and disc guide.

POSITIVE TIGHTNESS
is assured because the seat is machine-lapped to optical flatness.

STABLE PERFORMANCE
is certain because the spring is exposed, and the blowdown control is uniform.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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SUPER-FINISH Stic-Tite

The One-Coat Insulation

for Your Boilers • Tanks
Heaters • Fans • Ducts
Hot Walls • Uptakes
Breechings • Pipings • Fittings

✓ Finishes Smooth in One Coat

over insulating blankets, block, plastic insulating base or brick. No roughing coat needed.

✓ Finishes Hard, White, Resistant

to moisture or steam. Efficient — at all temperatures to 1700°F.

✓ Stays on Permanently

without shrinking, cracking or peeling. No pointing up or patching necessary. Adheres strongly to overhead, vertical or curved surfaces.

✓ Goes a Long Way

Super-Finish Stic-Tite has double the coverage of asbestos cement. Lowest cost coverage of any one-coat finish insulation.

✓ Easy to Apply

Simply mix dry finely ground pure white material with water and trowel—generally about ⅜" thick.

Try a 25-lb. bag of Super-Finish Stic-Tite.— No obligation

REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

130 WALL STREET • NEW YORK 5, N. Y.

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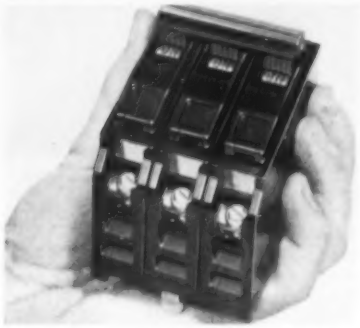
EQUIPMENT NEWS

continued from page 58

30—CIRCUIT BREAKER for lighting-distribution panels

This low-cost three-pole, 50-amp 240-v frame circuit breaker is reported to permit major cost savings for combination lighting and distribution panels. It is designed to extend usefulness of QO circuit breaker panelboards and loadcenters for three-phase, three- and four-wire, 240-v a-c circuits as well as single-



phase, two- and three-wire circuits. Manufacturer says the sequence bus connections permit any adjacent single poles to be changed to double poles on any bus, as well as three poles on three-phase arrangements. It is available in five 240-v ratings from 15 to 50 amp. The breaker's operating mechanism is quick-make, quick-break with a thermal and independent magnetic trip. It is noted that this breaker permits use of less expensive panels and loadcenters on most combination lighting and motor loads without sacrificing safety or maximum performance The Square D Co.

Reader Service Cards on pages 127–128 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

31—DRUM RECORDER monitors work being done

Model MD-jr is a compact "operations" or "events" recorder and consists of a drum which rotates at speeds from 4 min to 24 hr per turn (as ordered). It is used to record graphically when a machine or device is operating or when an operator is producing. No ink is used. A stylus rests against the chart paper with its adherent layer of white opaque wax crystals — pressure of the stylus exposes the contrasting color of the paper beneath.

The stylus produces a slight spiral tracing on the chart. The lead screw is also subject to an axial motion from the magnet responding to the input signal to cause the vertical line. By this means, more than 400 linear inches of recording can be had on a waterproof chart only 6 ft by 14 in. When the 24-hr rotation

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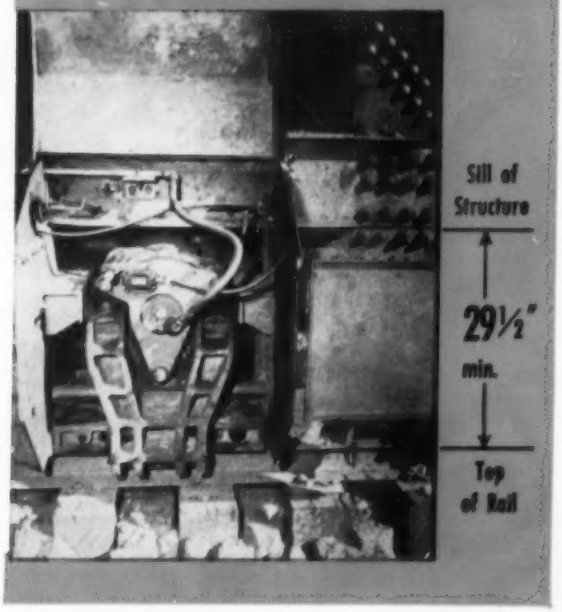
Rail Clamps

provide *new advances* in safety...economy...reliability

This rail clamp can be installed under the sills of most bridges or towers



- Rollers keep the clamp centered on the rail
- Structure cannot be propelled until clamp is fully released
- Adjustable metering valve delays clamping action until structure comes to rest
- Made to fail safe
- Large area shoes, with coarse serrations, keep clean and prevent damage to rails
- Visual indication shows wear of shoes
- Clamps can be applied automatically or at the direction of the operator
- No toggles, cams or complicated mechanism . . . self-adjusting

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MEAD-MORRISON

Division of
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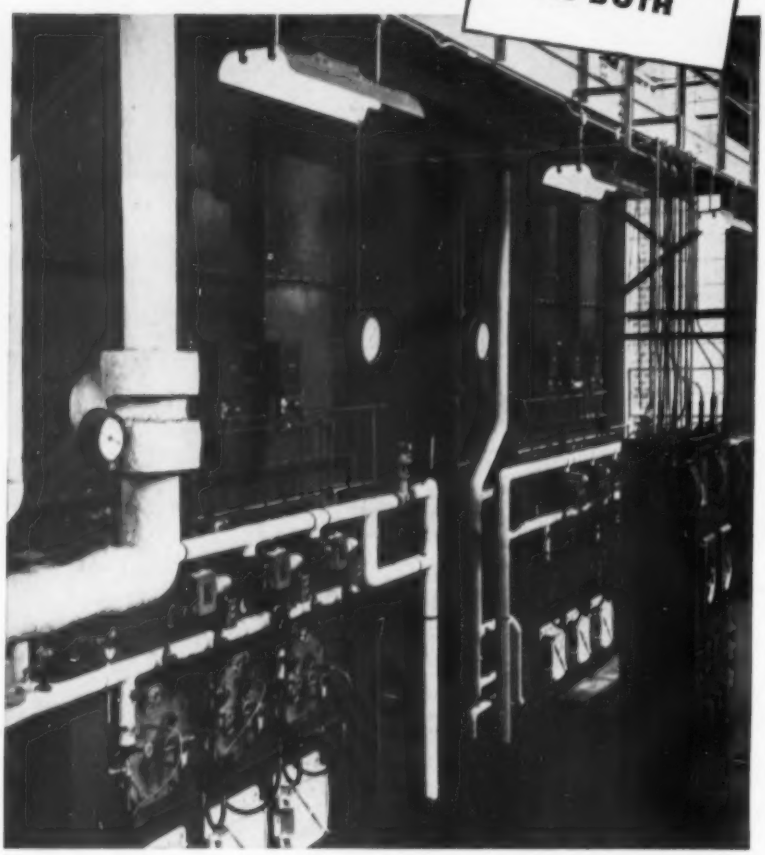
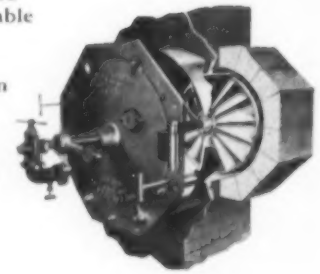
ENCO BURNERS

FOR OIL, GAS OR BOTH



This New England textile mill uses Enco Type K oil burners. When gas is available a gas-burner gun can be added for dual fuel firing.
Combustion in any case is uniform even if steam demands fluctuate suddenly—another economy feature.
This is only one example of economy with Enco Burners—made in sizes and types for every power plant need, including those with very wide load swings. Ask for literature or a special recommendation for your specific, individual oil or gas burner needs. We will give it the benefit of 35 years' experience in solving unique burner problems.



Enco type K oil burning unit

ec-489

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

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model is used, any given constant of successive days is instantly comparable since they line up vertically. Motors operate on 115 or 220 v a-c. Styli coils for 6 to 220 v a-c or 6 to 120 v d-c. A 5000-ohm electronic coil is available. The recorder costs about $60.00 with 100 sheets of paper. Gorrell & Gorrell.

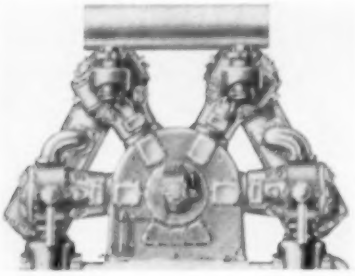
32 — LOW TEMP INSULATIONS of expanded polystyrene

Announced as remarkably effective in resistance to vapor transmission and moisture, this expanded polystyrene insulation is available as Styrolite, a board form, and Styrocel, a custom molded pipe covering. According to manufacturer, Styrolite and Styrocel feature high compressive strength, light weight, ease of application, low thermal conductivity and durability. They are suggested for cold storage rooms, freezers, refrigerant piping, duct work and similar low temperature applications.

Styrocel is available in ½ to 20 in. IPS, and ⅝ to 4⅛ in. OD for copper tubing in thicknesses from 1 to 2½ in. Styrolite comes unpackaged in six sizes from 12-by-36 in. to 36-by-72 in., in thicknesses of 1 to 8 in. The two smallest sizes may be had in tubes or cartons. The insulations cut readily, it is noted, and easily used. Mundet Cork Corp.

33—AIR COMPRESSOR in the 350 to 1000 hp range

The WN-224 is the largest package-type compressor available, according to manufacturer's report. Output at 80–125 psig is rated from 2418 to 6048 cfm, depending on motor horsepower. The compressor is a four-cylinder, double-acting,



water-cooled machine of semi-radial design, achieving final pressure in two stages. Three standard single models and three "twin unit" models are available, plus corresponding altitude sizes. Twin units consist of two standard compressors powered by one motor. High and low pressure variations are also available. Drive may be by electric motor, flange mounted or coupled, or by diesel engine, steam turbine or turbo-electric combinations. The compressor measures 9 ft 8 in. high by 12 ft 8 in. wide. Length ranges from 8 ft 7 in. to 14 ft 2 in. Twin units are from 20 ft 11 in. to 21 ft 11 in. Joy Mfg. Co.

34—HIGH VOLTAGE FUSE has greater interrupting capacity

The 9F9D-9 is announced as a high voltage fuse with 3.3 times the 60-cycle interrupting capacity of its predecessor. It is now standard with company's stack rack capacitor equipments utilizing 50-kilovar units. The fuse is reported

Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits. CAUSE: *lack of chemical stability in feed water.* REMEDY: *properly balanced water treatment.*

LINE OF MOST RESISTANCE

A heavy build-up of scale, like that shown in the illustration, will gradually reduce the effective diameter of feed line piping, and will result in seriously restricted carrying capacity.

The line must be shut down for maintenance or replacement, causing expensive down time in the plant. Proper water conditioning will prevent this unnecessary loss. This is but one of the many problems presented by the corrosive elements of water.

In Dearborn's complete line of water conditioning products, there are treatments to eliminate scaling, sludge, carry-over, return line corrosion and other similar difficulties. Dearborn combines the proper treatment with the right control methods under technical supervision. The result: less down time and greater operating efficiency.

Dearborn Supervisory Service provides you with the three elements necessary to maintain the best in a water conditioning program—positive control, top performance effectiveness and maximum economy.

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. . . and the P-D Tubular is even more radical. Unique internal ducting, called *PLENAFLO, actually provides a plenum *within* the collector casing which permits direct gas flow to the inlet of the tubes *unhampered by a maze of outlet tubes.* It also permits the use of tube bundles so designed that the gas *never has to pass more than two tubes* to reach the most isolated central tube. This patented feature reduces resistance and eliminates gas recirculation that can occur with outlet tubes of varying length.

Further improvement of gas flow was accomplished by designing the tube inlet slots to permit the gas to enter the tube at a natural angle and around the complete periphery of the tube. This reduces sudden changes in direction of gas flow and attendant wear.

Ask our project engineers for information on this unique PLENAFLO collector. Its efficiency and limited space requirements will be of particular interest. Available in either vertical or horizontal tube design sheets, it assures installation flexibility.

Write today for Bulletin on this radical design.

*Trademark

Project Engineers
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GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

pd

Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

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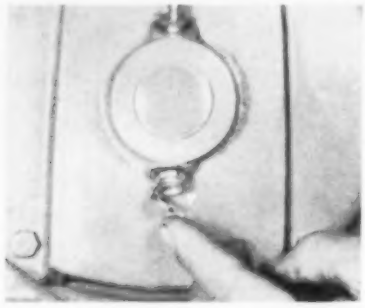
to isolate faulty units, allowing a capacitor bank to continue operation without danger of rupturing a failed capacitor. A fiber glass tube wall is designed to give fuse superior mechanical strength and a high degree of resistance to natural elements. According to company, this tube strength provides satisfactory operation of fuse when stored energy of an adjacent capacitor is four times greater than previously permitted. It is installed by screwing one end into the buswork of a bank of equipment. A lead from fusable element extends from other end, is attached to capacitor terminal. Rating is 8.7 kv, 4,000 amp. General Electric Co.

35—RELIEF-TYPE FITTING speeds up bearing lubrication

For use on antifriction bearings in motors, machinery, pillow blocks, or any ball or roller bearing housing equipped with conventional relief plugs, the RT Fittings have a "flip-open" cap that simplifies bearing lubrication. The body



of this fitting is internally flared to allow free discharge of excess grease. These fittings make the use of relief plugs unnecessary. According to company engineers, tests show that the RT Fittings cut lubricating time by 80 per cent. Although the cap is held tightly in place by spring tension, it snaps open or shut with the flip of a finger, manufacturer points out. No tools are needed to open the cap; it swivels to any position, so it is easy to reach. Because it is attached to the fitting, this cap cannot be misplaced. Keystone Lubricating Co.

36—A-C SENSITIVE RELAY with transistor amplifier

This electronic component is designed to resist vibration, corrosion and shock. Standard features include a two pole, double throw plug-in relay protected by a clear polystyrene dust-proof cover; a long life plug-in transistor amplifier and power pack module; 12-v d-c sensing circuit and low-sensing circuit current (less than 0.002 amp). Company says no warm-up time is required, and a convenient terminal board is provided for external connections. Its price is reported to be substantially lower than many comparable products.

Low capacity contact making devices such as drop wires, feeler switches and gages, contact making instruments, sensitive thermostats and slow-make, slow-break contacts will operate without electrical damage when used with this relay, it is announced. Its high speed operation suggests use in stop motion or sorting circuits. The low voltage noninductive circuit results in no visible arc, manufacturer notes, and thus elimi-

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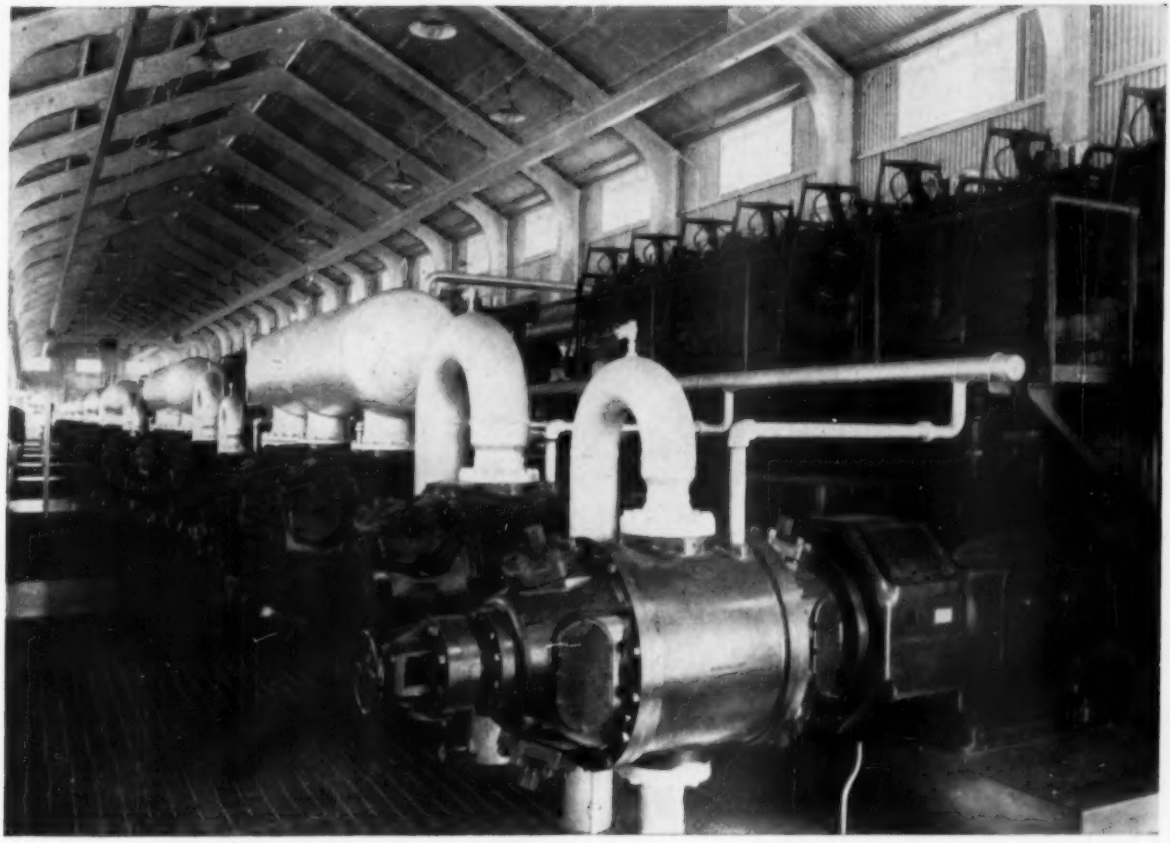
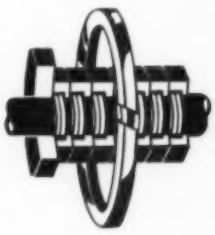


Cook packing and rings help keep compressors humming!

A well-known oil-producing company keeps this big lineup of Clark Bros. compressors running night and day in a West Texas gasoline plant. Keeps them running smoothly and efficiently, too — *thanks in good measure to C. Lee Cook packing and piston rings!*

Whatever type industrial equipment you operate, if it uses piston rings and packing, chances are good that it was Cook-equipped *when it was built.* That's why your best bet for continued trouble-free performance is to *keep it Cook-equipped.*

Your nearby C. Lee Cook representative will be glad to give you all the facts about precision-engineered Cook products. Why not talk with him soon? C. Lee Cook Company, 938 South 8th Street, Louisville 3, Kentucky.



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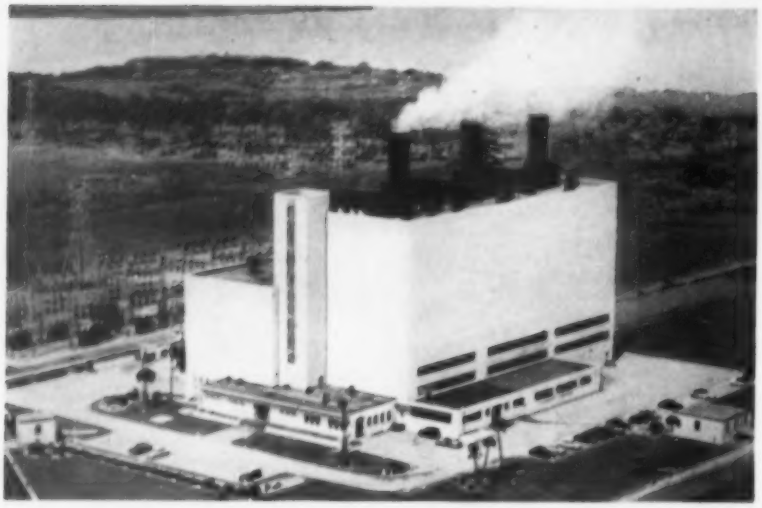

Kuljian projects like these are engineered—and custom-built—with a practical knowledge of modern power development. They combine balanced design . . . selection of equipment properly arranged and assembled . . . and are pre-planned to assure maximum flexibility and capacity for meeting the heaviest load requirements. To owners of electric utilities or industrial power plants, Kuljian offers a wide range of power engineering services plus an experience record spanning *twenty-seven years.*

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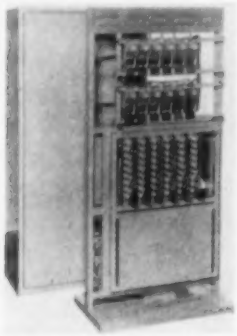
nates fire hazards on applications where sensing contacts must be near flammable material. Long distance remote control, liquid level control and photo cell applications are also possible. Rated up to 10 amp, 110 v, 60 cycles, the relay comes in an open type panel or NEMA Type 1 general purpose enclosure. Bulletin 13535 gives data. Cutler-Hammer, Inc.

37—PRIVATE SWITCHBOARD for small plant requirements

Telecom Model 4A27 Dial Telephone Switchboard has been designed for plants requiring 20 to 46 private telephones. Switchboard comes completely

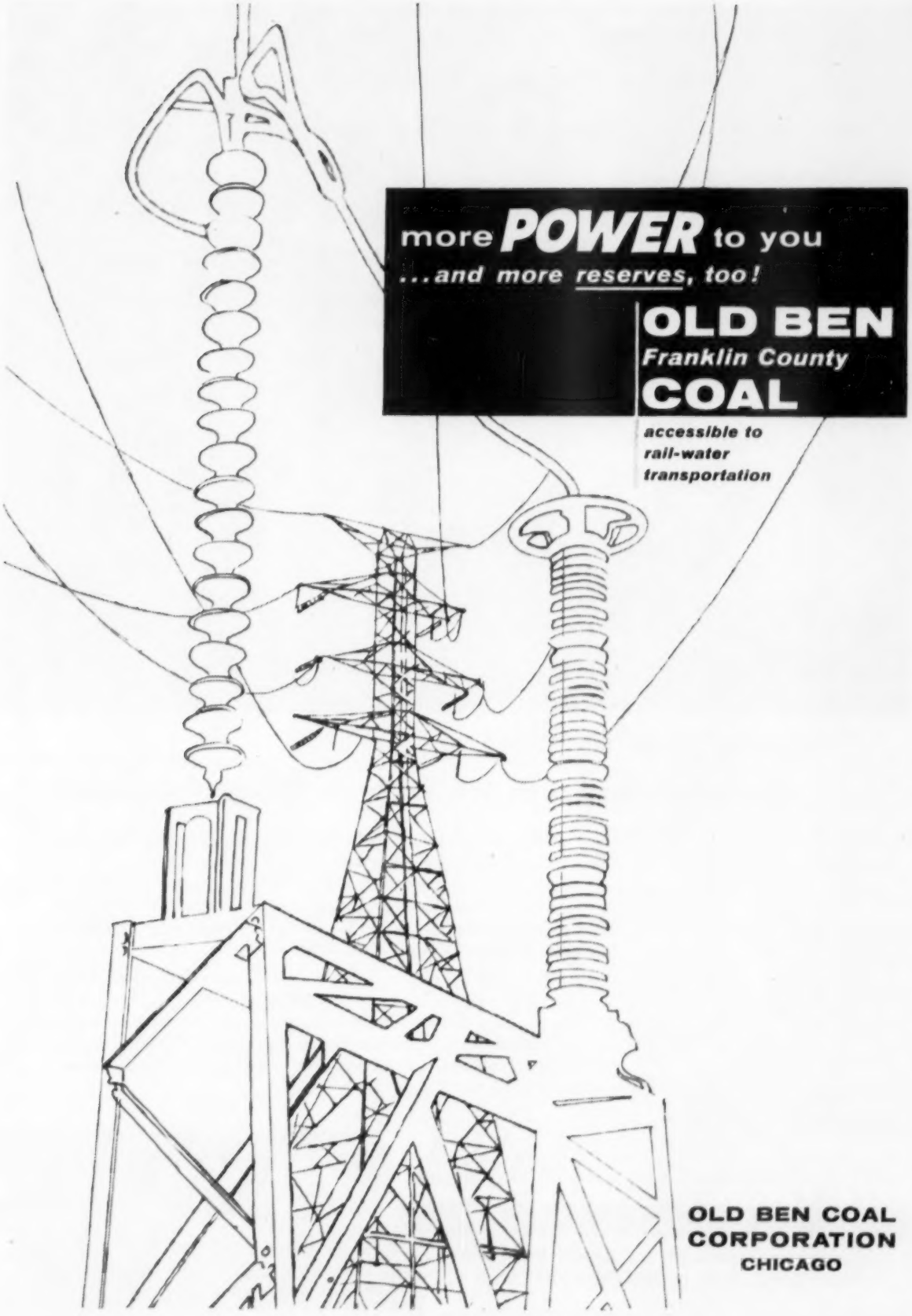


equipped and requires only the addition of telephones to be placed into operation. According to manufacturer, it provides top quality intercommunication service and has all the features of modern city type telephone service. In addition, many features are available, such as paging, speaker-phone, automatic code call, central dictation, etc. Telecom, Inc.

38—VARNISHED TAPE is improved insulation material

Fibremat Varnished Polyester Web Tape is said to have higher dielectric strength, lower power factor, lower moisture absorption and greater conformability than many varnished insulations. It is rated as a Class A insulation material, and suggested for wrapping field coils, phase insulation in electric motors, insulating generators and transformers and for cable insulation and splicing. General resistance to water, salt water, acid and alkalies is described as excellent.

An important property of the tape, according to company, is conformability. Due to the ease of elongation of its polyesterweb base, the tape can be pulled down tightly while wrapping to eliminate air pockets or voids. Elongation of the tape has no marked effect on its dielectric properties, it is noted. This ability to deform only at point of pressure is attributed to the non-continuous fiber base. The same property improves the tape's tear resistance. This tape differs from woven fabric tapes in being made up of a mat of non-woven polyester fibers in felted form, impregnated with a varnish coating. The polyester base serves to provide a material which can be stretched without losing electrical properties, and since this base is virtually moisture-proof, wicking of moisture, common to many base fabrics, is claimed solved in Fibremat. The tape comes in 7- and 10-mil calipers in black or yellow varnish. Minnesota Mining and Mfg. Co.



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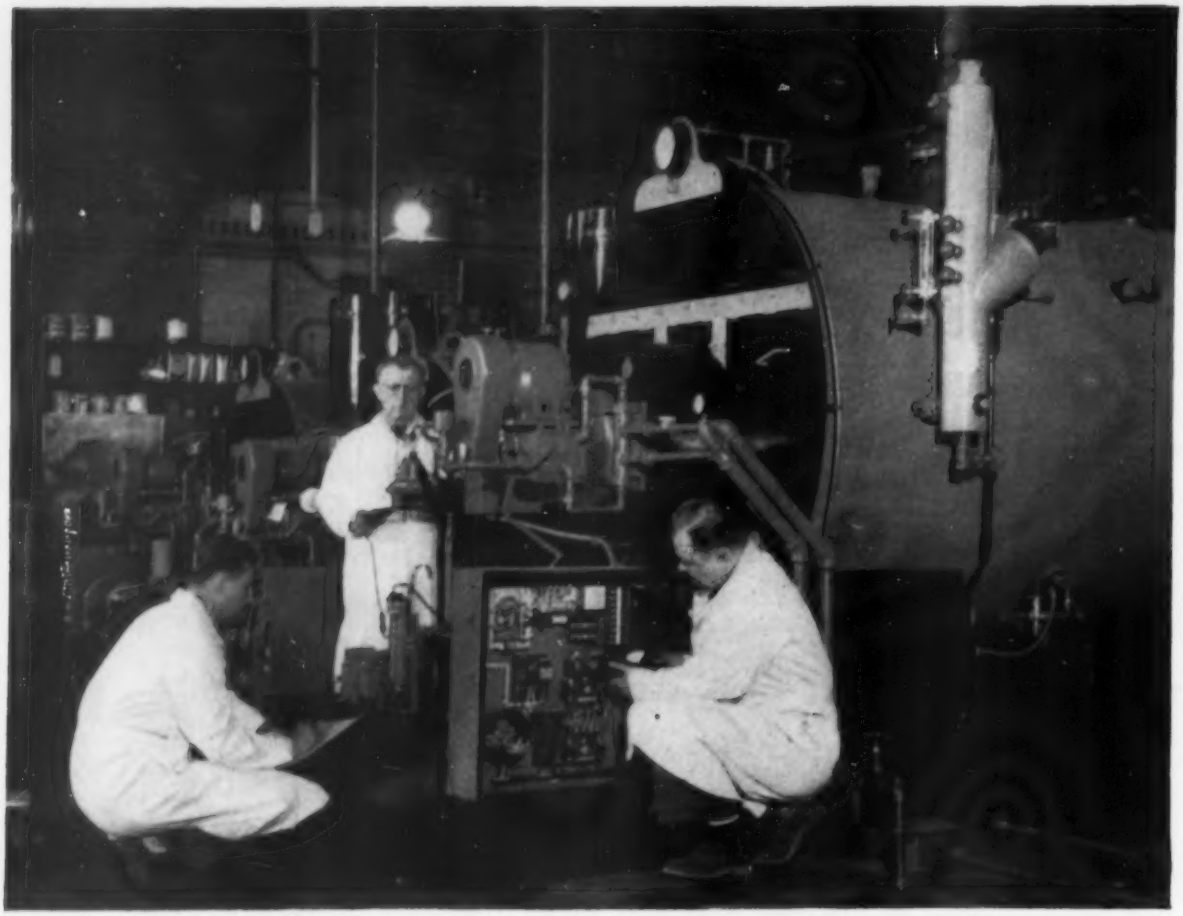

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COAL, ASH HANDLING

201 Tractor Shovel — The engineering, design and production stories of company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes various features which mean easier servicing for less time-down and greater operator comfort. Allis-Chalmers Mfg. Co.

202 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

203 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

REFRACTORIES, INSULATIONS

204 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

205 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-p illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

206 Refractory Castable — Bulletin R-40 describes use of Kaocrete-32, a high temperature refractory castable, in boiler ashpits. A discussion of various methods of ash removal, along with maintenance problems peculiar to each, is presented. Four typical installations are detailed. Refractories Div., The Babcock & Wilcox Co.

207 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for effi-

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5	6	7	8	108	109	110	111	112	113	114	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246
9	10	11	12	115	116	117	118	119	120	121	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269
13	14	15	16	122	123	124	125	126	127	128	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292
17	18	19	20	129	130	131	132	133	134	135	293	294	295	296	297	298	299	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516
21	22	23	24	136	137	138	139	140	141	142	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539
25	26	27	28	143	144	145	146	147	148	149	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562
29	30	31	32	150	151	152	153	154	155	156	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585
33	34	35	36	157	158	159	160	161	162	163	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605			
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TUBING AND ACCESSORIES

208 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

209 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required tubing that would withstand this rigorous wear. The International Nickel Co., Inc.

210 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

211 Tube Expanders — Catalog 88, 119-pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is fully described, applications are listed, and tables of engineering data included. Also covers tube expansion methods, tool maintenance, expansion calculations and charts giving sizes. Thomas C. Wilson, Inc.

BOILERS, GENERATORS

212 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

213 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

215 Hot Water Boilers — This 20-pp brochure describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications. Combustion Engineering, Inc.

216 Compact Generator — This bulletin describes a packaged water tube generator, company's Type DK, available in units for 8400 to 45,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to

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17	18	19	20	129	130	131	132
21	22	23	24	136	137	138	139
25	26	27	28	143	144	145	146
29	30	31	32	150	151	152	153
33	34	35	36	157	158	159	160
37	38	39	40	164	165	166	167
41	42	43	44	171	172	173	174

105	106	107	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521
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126	127	128	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584
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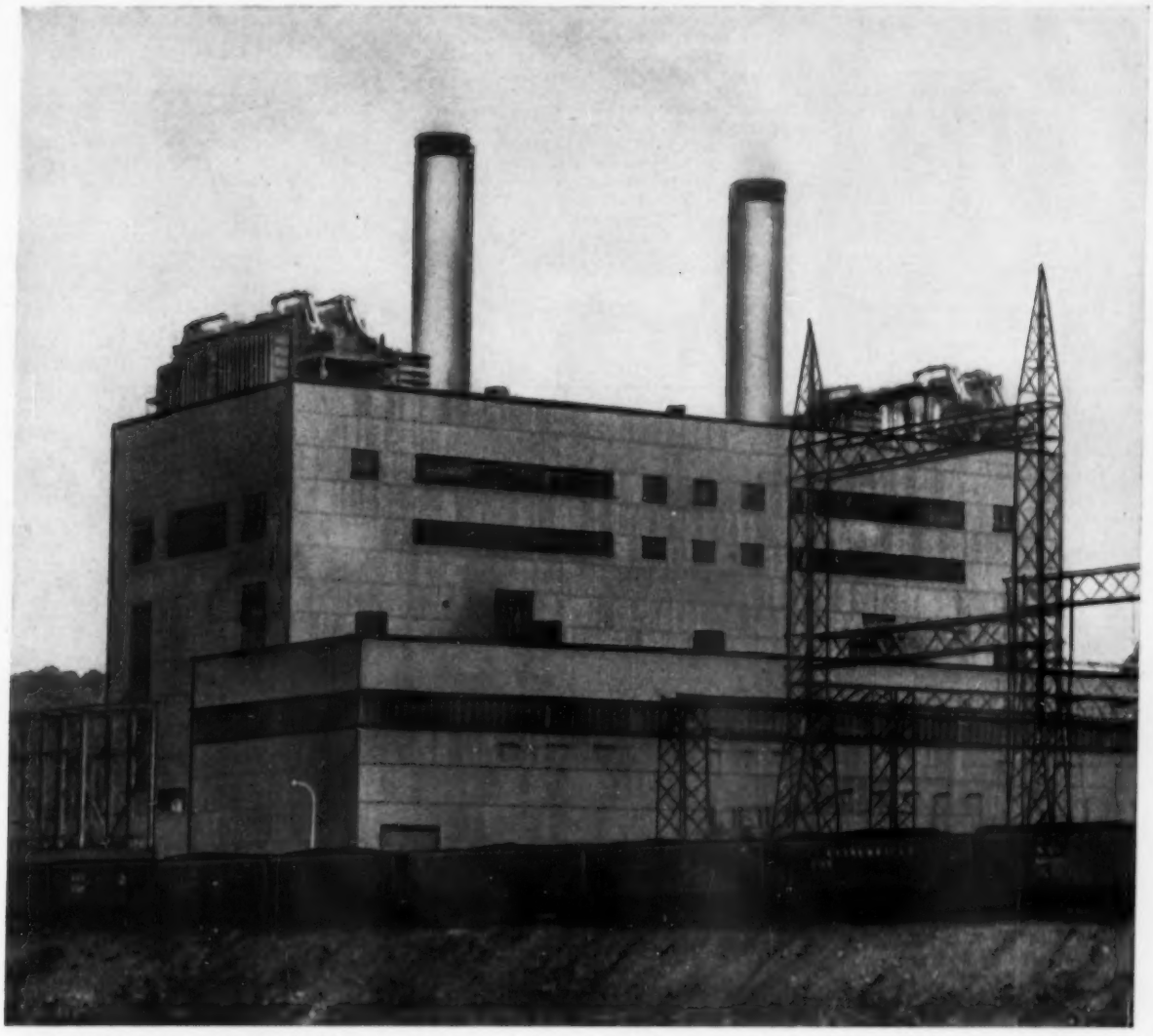

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require less space than many water tube units. E. Keeler Co.

217 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

218 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

219 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data and dimensions for the units. Preferred Utilities Mfg. Corp.

220 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

221 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

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This Bowser turbine oil conditioning system keeps oil "bone dry" and crystal-clear . . . the best "stay-on-the-job" insurance a turbine bearing can have. Costly bearing failures are avoided and less stand-by equipment is required with Bowser oil conditioners. Bowser-conditioned turbine oil lasts for years, too! That's why Bowser oil conditioners are on the job in a majority of power plants.

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FUEL BURNING EQUIPMENT

223 Oil and Gas Burners — Bulletin OB-53 28 pp gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

224 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

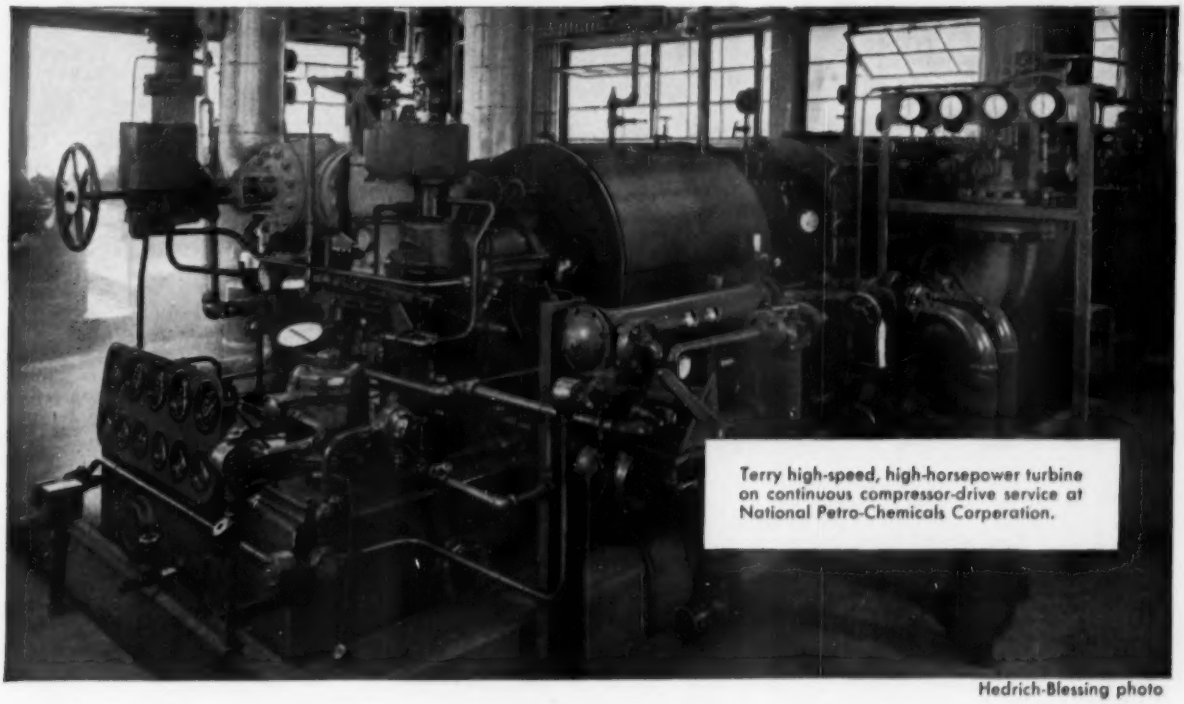
225 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

WATER CONDITIONING

226 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

228 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrite, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

230 Deaeration Literature — The facts about deaeration are thoroughly reviewed in a series of bulletins available from the company. What deaeration is, why it is necessary, and types of deaerators are among the subjects covered in one of



Terry high-speed, high-horsepower turbine on continuous compressor-drive service at National Petro-Chemicals Corporation.

Hedrich-Blessing photo

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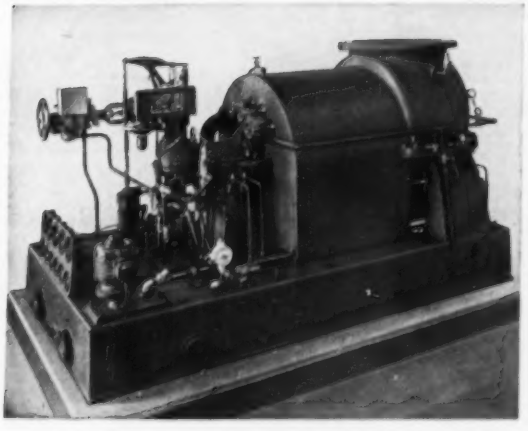
Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

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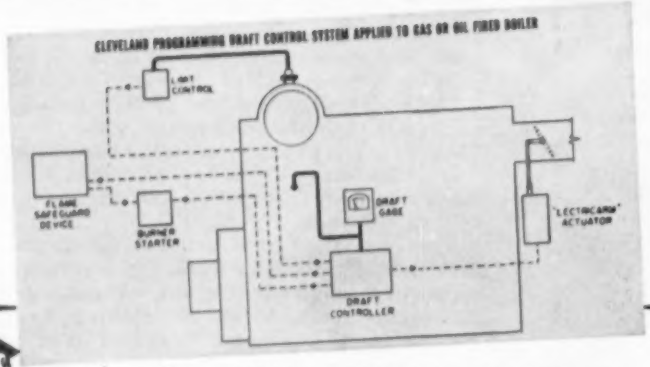

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the bulletins. Others in the series describe various types of deaeration equipment, including the Jet-Tray deaerator, tray-type deaerators, cold water deaerators, a surface type deaerating hot water heater, boiler feedwater deaerating heater, and atomizing deaerators. Cochrane Corp.

231 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

232 Mixed-Bed Di-Ionizers — Practical equipment for mixed-bed di-ionization at flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation, operation. Illinois Water Treatment Co.

233 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

234 Carbon Dioxide Measurement — Technical Paper 133, 16-pp, discusses determination of CO_2 in water by conductivity measurements. Describes a new method developed for the determination of carbon dioxide which is applicable to analysis of waterside deposits, treatment chemicals and organic carbon in water. Betz Laboratories, Inc.

235 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

236 On Demineralization — Technical Reprint T-140, 23-pp, a profusely illustrated article on demineralization, discusses advantages and disadvantages of this process for today's power plants. Developments, trends and applications of both multi-bed and mixed-bed ion exchange are considered, and several case histories cited. A comprehensive bibliography lists 119 separate items. Tables, flow sheets, descriptive drawings, performance curves, process selection charts included. Graver Water Conditioning Co.

237 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine, and properties and handling of the material. Comprehensive operating data given. Olin Mathieson Chemical Corp.

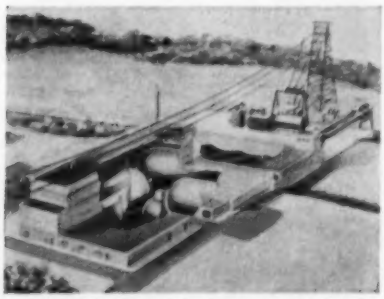
238 Feed Water Deoxygenation — The advantages of chemical deoxygenation of boiler feed water with an aqueous solution of hydrazine are described in 12-pp Bulletin BW 5. How hydrazine serves to maintain boiler in cleanest possible condition, reducing iron oxide scale to a mag-

Anaconda Arsenical Admiralty-439 Tubes being installed in the condenser at the Shippingport, Pa., Atomic Power Plant—25 miles northwest of Pittsburgh.

CONDENSER IN AMERICA'S FIRST BIG ATOM POWER PLANT USES 60 MILES OF ANACONDA ARSENICAL ADMIRALTY TUBE

The electric generating station at the Shippingport, Pa., Atomic Power Plant will add a maximum 100,000 kw of electric power capacity to Duquesne Light Company's system when it is placed in operation this year.

More significant, however, is its function of measuring the performance of the Pressurized-Water Reactor. It will help give some of the answers on how to "burn" uranium on a large scale and utilize the power economically, to guide design of future atomic power plants.



A SKETCH of The Shippingport Atomic Power Plant, cut away to show containment vessels housing the pressurized-water reactor and heat exchangers which generate steam to operate the turbine-generator. The condenser is located directly beneath the turbine-generator shown in the background.

The Westinghouse Turbine-generator has a minimum rating of 60 megawatts and a maximum of 100 megawatts. It operates on saturated steam at low pressure—987,350 lb/hr at a throttle pressure of 620 Psia, for 79.3 megawatt gross generator load. It is served by a 70,000-sq.-ft. Westinghouse condenser which provides a condenser vacuum of 1.5 in Hg Abs.

The condenser has a total of 10,276 Anaconda Arsenical Admiralty-439 tubes, 7/8" O.D. x 18 Stubs' gage x 30 ft. long, with a total weight of 153,676 lb. The tube plates of "true oval shape," 153" x 213" x 1½" thick, are of Leaded Muntz Metal, each weighing approximately 12,450 lb. These, too, were supplied by The American Brass Company.

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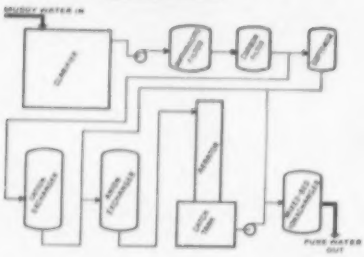

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netic oxide, is fully detailed, and such considerations as economy and operation, handling precautions, storage are covered. Fairmount Chemical Co., Inc.

ELECTRICAL EQUIPMENT

239 Testing Instruments — Bulletin 19-57, 16-pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

241 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper, its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

242 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. All information is condensed. Fully illustrated, book gives wiring diagrams, motor tables. Bussman Mfg. Co.

VALVES, TRAPS, PIPING AND ACCESSORIES

244 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

246 General Purpose Valves — Supplement No. 1 to Catalog F-9, 32-pp, offers complete information on company's series of general purpose drop forged steel valves, gate, globe and angle types, sizes ¼ through 2 in. Includes descriptions of each type along with drawings showing component parts. Dimensions and other specifications are tabulated, and a pressure-temperature ratings table is included. Henry Vogt Machine Co.

247 Diaphragm Motor Valve — Bulletin J-170 describes outstanding features of company's diaphragm motor valve designed for accurate control of pressure, temperature, rate of flow, and liquid level. Cutaway view showing component parts is included, along with data on materials of construction, capacity tables, and flow diagram. The Jordan Corp.

248 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves,

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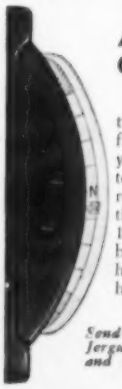

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slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

249 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

250 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

251 Valve Chart — Form 194R, 22 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

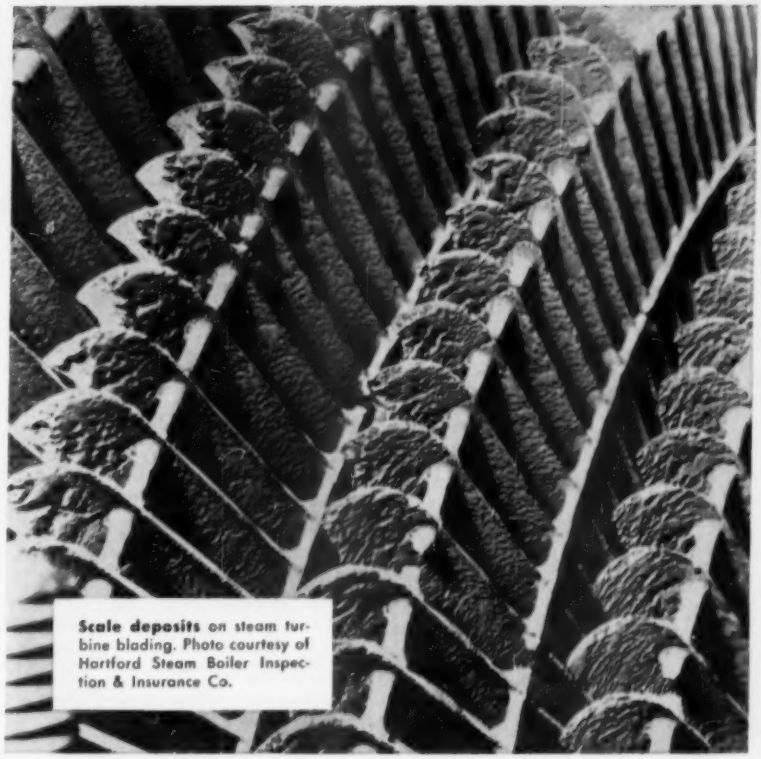
252 Bronze and Steel Valves — Catalog 200, 80 pp, describes company's bronze and steel valves, including globe, angle, gate, Flocontrol and other types applicable to power, petroleum, chemical and general industry installations. Engineering data such as material specifications, flow charts, temperature and pressure ratings are included. The catalog is profusely illustrated with photos, cutaway views and dimensional drawings. Manning, Maxwell & Moore, Inc.

253 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

256 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as trouble-shooting and repair. Armstrong Machine Works.

257 Steam Trap Selector — Twelve-pp Bulletin T-9 is designed specifically to aid in selection and application of steam traps on chemical processing equipment. Features a foldout piping diagram for 22 pieces of typical processing equipment — each showing recommended steam trap and piping arrangements. Also contains selector tables. Yarnall-Waring Co.

258 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling



Scale deposits on steam turbine blading. Photo courtesy of Hartford Steam Boiler Inspection & Insurance Co.

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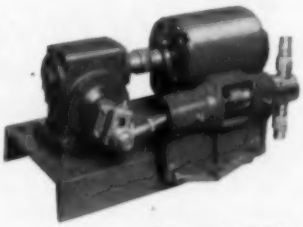

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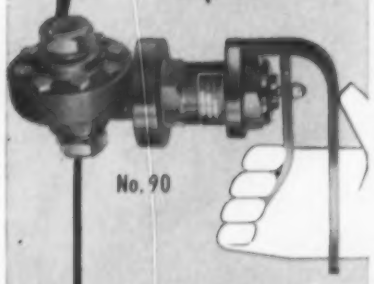

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asphalt and other liquids that solidify unless heated. Barco Mfg Co.

MECHANICAL POWER TRANSMISSION

259 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

260 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

261 Internally Geared Power — Featuring latest design improvements in gearmotors and embodying 60 multicolor illustrations, 16-pp Form F-1880 shows comparative advantages of gearmotors, lists ratings from ¼ to 30 hp with gear ratios as high as 10:1. Cross-sectional details and enlargements of outstanding features are included, as well as a discussion of use of elliptoidal helical gears, and a chart graphing degrees of tempering of gear teeth. U. S. Electrical Motors Inc.

INSTRUMENTS, CONTROLS

262 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

263 Instrument Panels — Power and process plants can choose instrument and control panels to meet individual specifications from six standard designs described in 16-pp Product Specification G71-7. Complete specifications are furnished, as well as information on supports and mountings for tubes, wires and equipment, instrument mounting dimensions, and dimensions of standard instrument and control panels. Bailey Meter Co.

264 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

265 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

267 Control Fundamentals — Three important factors in combustion control — safety, efficiency and long life — are considered in detail in 16-pp Form EB-1-756, the first of a series. Reviews

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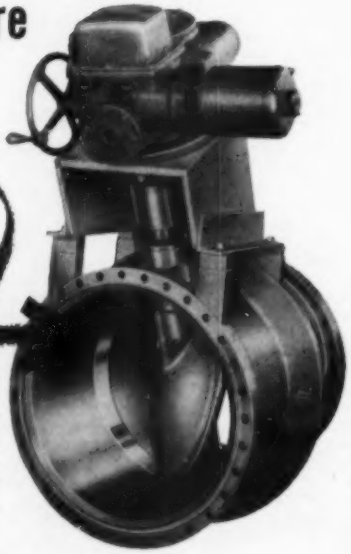

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basic concepts involved in automation in combustion, or the provision of automatic means for sensing heat requirements to assure correct proportioning of fuel and air under optimum conditions. Fundamentals of controls common to all systems are covered. Cleveland Fuel Equipment Co.

269 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

270 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features, describes applications. Hagan Corp.

271 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

272 Remote Reading Gages — Eight-pp Catalog 291, revised, shows new designs in remote reading liquid level gages, including the Red Flasher Truscale. This has a scale which flashes continuously in red for a positive warning when boiler water level gets too high or too low. Profusely illustrated with photos and engineering drawings, catalog covers gages in four pressure groups from under 900 to over 1500 psi. Jerguson Gage & Valve Co.

273 Bi-Color Gage — Bulletin 1174 gives advantages of company's Multi-Port bi-color gage made for boiler operating pressures to 3000 psi. Points out chief design features, illustrates construction details through photos and drawings. Diamond Power Specialty Corp.

274 Ideas on Push Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

PUMPS AND PUMPING

275 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

277 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal

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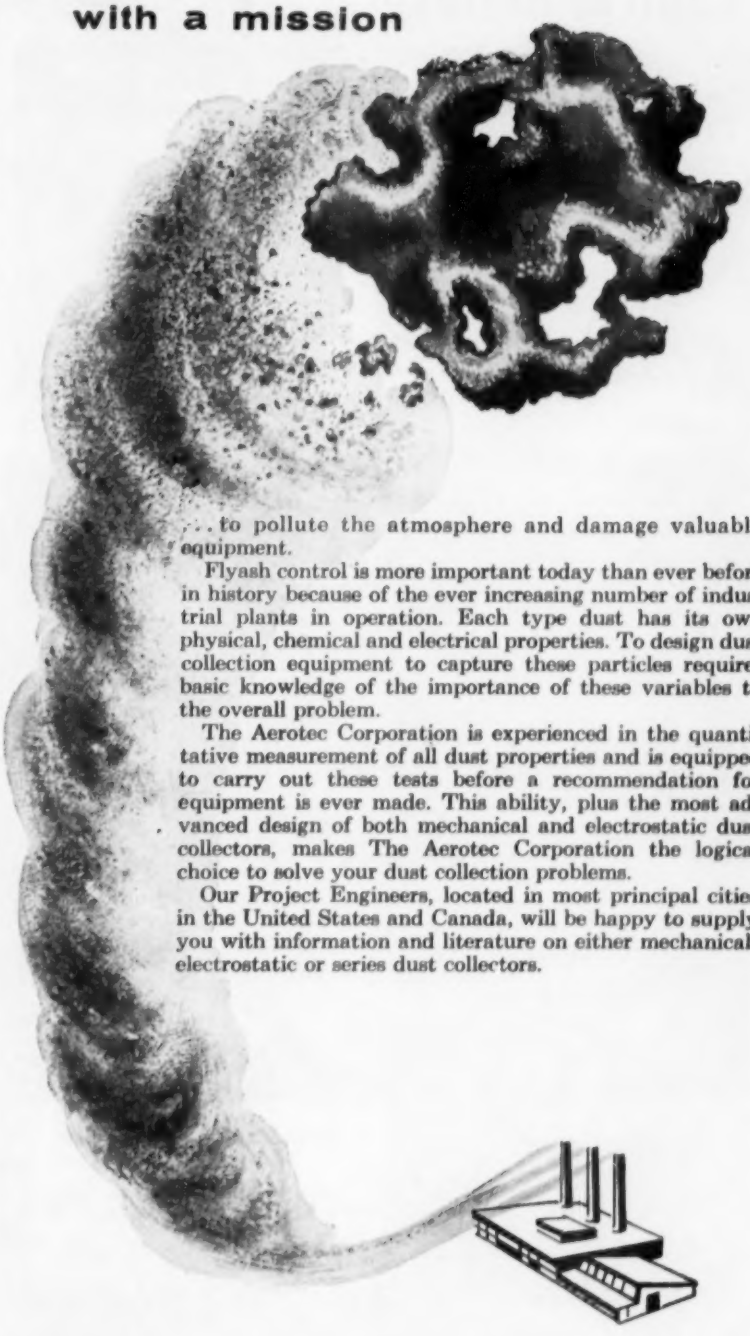

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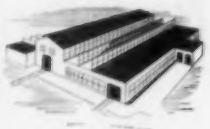

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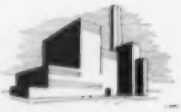

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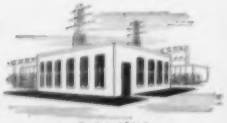

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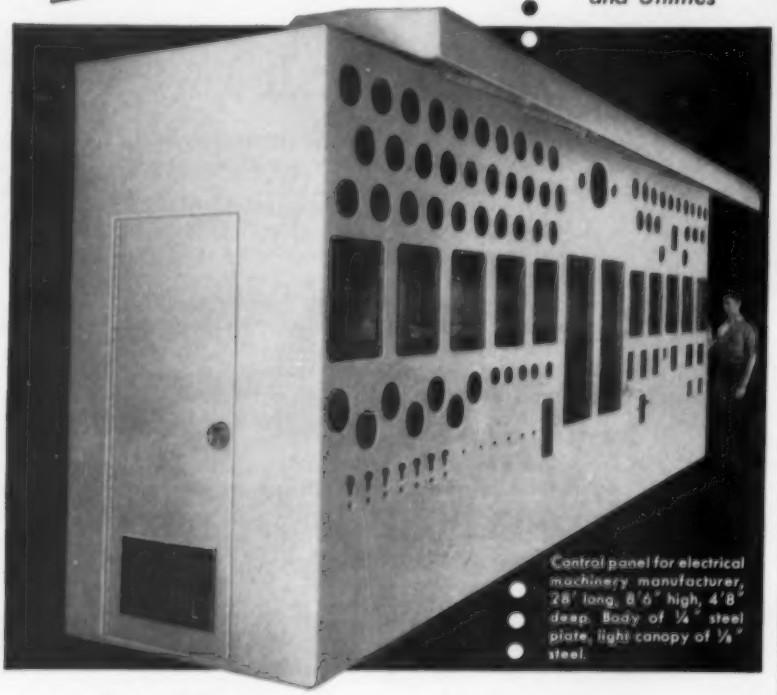

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278 **Steam Pump Care** — Bulletin G-2280, "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners. Worthington Corp.

279 **Solids Handling Pumps** — Bulletin 121-A, 8 pp, describes a complete line of non-clog pumps for handling solids in suspension. Included are vertical, horizontal and close-coupled types used to handle liquid components of industrial processes, industrial waste, and for such pumping applications as water supply, drainage and sewage handling. Specifications are included. Aurora Pump Div., The New York Air Brake Co.

280 **Meter that Pumps** — Bulletin 300, 8 pp, describes company's improved meter that pumps — designed for precise metering and proportioning of small quantities of low viscosity fluids at low cost, over extended periods of time. Complete capacity tables and a detailed schematic are also included. Hills-McCanna Co.

LUBRICANTS

281 **Lithium Soap Greases** — This product information bulletin details qualities and specifications of company's multipurpose soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures are discussed, together with performance characteristics. Sinclair Refining Co.

282 **Bearing Lubrication** — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved, in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

PACKINGS, SEALS

283 **Packings and Gaskets** — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

284 **Mechanical Seals** — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service

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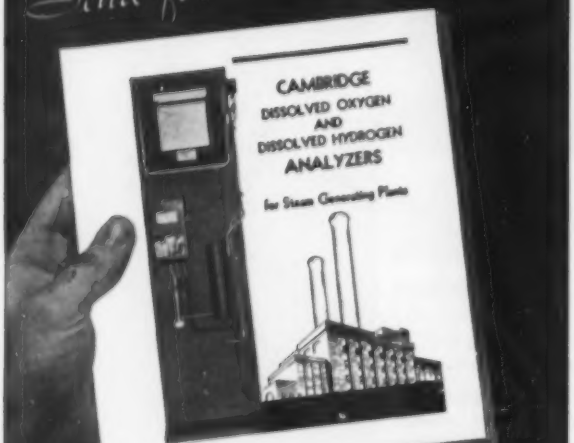

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285 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure involved in the work. De Laval Steam Turbine Co.

286 Heavy Duty Fans — Eight-pp Bulletin 4824 describes new Airfoil centrifugal fans for heavy duty industrial applications. Discusses performance features and construction details of the fans. Text is supplemented with photos and drawings of wheel, housing, bearing, shaft. Several possible volume control methods that can be used with these fans are described and evaluated. Brake horsepower curves for four volume control methods are included. American Blower Corp.

288 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

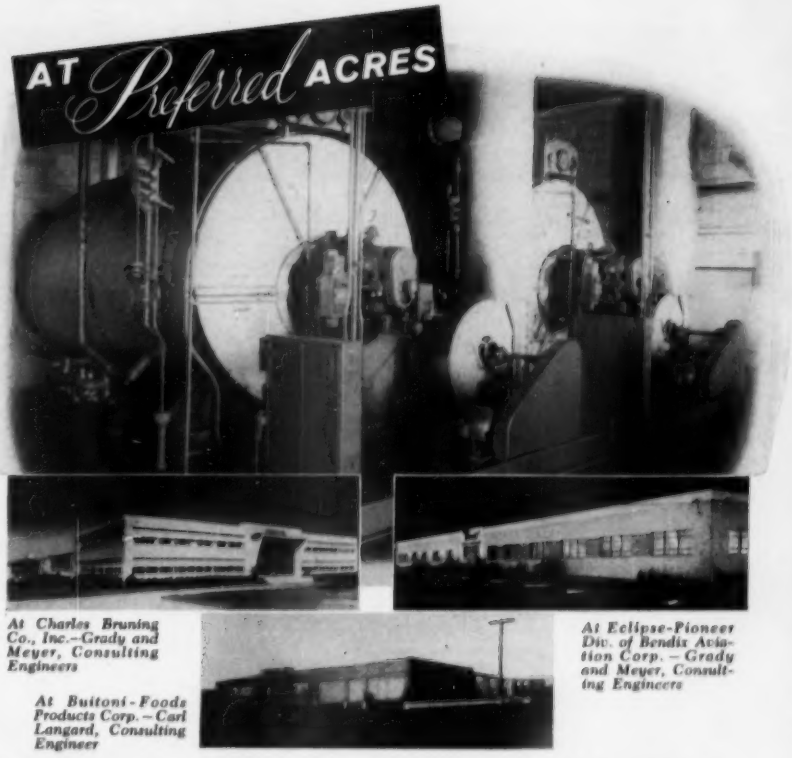
289 Burning Bituminous Coal — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems overcome, equipment used, and savings realized. Bituminous Coal Institute.

290 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

291 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

292 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

293 Technical Refrigeration — Twelve-pp Bulletin 754 covers a complete line of environmental testing and processing equipment. Provides illustrations and specifications on recently redesigned altitude, humidity, low temperature and prefabricated test chambers as well as specialized testing equipment. Includes helpful engineering data. Bowser, Inc.



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Agency—The Michener Co.
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POWELL VALVES 27
Agency—The Ralph H. Jones Co.
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Agency—Hening & Co.
PREFERRED UTILITIES MFG. CORP. 141
Agency—Spooner & Kriegel
PROPORTIONEERS, INC. 135
Agency—Horton, Church & Goff, Inc.

RAYBESTOS-MANHATTAN, INC. 30
Agency—Gray & Rogers
REFRACTORY & INSULATION CORP. 118
Agency—Spooner & Kriegel
RELIANCE GAUGE COLUMN COMPANY 56
Agency—Carr Liggett Advertising Inc.
REPUBLIC FLOW METERS CO. 34
Agency—Stoetzel & Associates, Inc.
RESEARCH-COTTRELL, INC. ..... *
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RIC-WIL, INC. 64
Agency—Ritchie & Sattler, Inc.
RILEY STOKER CORPORATION 18–19
Agency—Seth R. Martin
ROCKWELL CO., W. S. 136
Agency—Spooner & Kriegel
ROSS HEAT EXCHANGER DIVISION ..... *
Agency—Harold Warner Co.
ROTO DIV. OF ELLIOTT CO. 28
Agency—Jos. Vogel & Co.

SARCO COMPANY, INC. 51
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
SARGENT & LUNDY ..... *
Agency—Armstrong Advertising Agency
M. SETLOW & SON, INC. ..... *
Agency—J. W. Shepard Co.
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Agency—Morey, Humm & Warwick, Inc.
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Agency—Compton Advertising, Inc.
SPENCE ENGINEERING CO. ..... *
Agency—Michel-Cather, Inc.
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Agency—D'Arcy Advertising Co.
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Agency—Bert S. Gittins Advertising, Inc.
STEPHENS-ADAMSON MFG. CO. 113
Agency—Connor Associates, Inc.
STICKLE STEAM SPECIALTIES CO. ..... *
Agency—W. H. Rohr, Jr.
STONE & WEBSTER ENGINEERING CO. 33
Agency—Harold Cabot & Co., Inc.
STRUTHERS WELL CORP. ..... *
Agency—Downing Industrial Advertising, Inc.
STURTEVANT MILL CO. ..... *
Agency—F. P. Walther Jr. & Associates, Inc.
SUPERIOR COMBUSTION INDUSTRIES, INC. 126
Agency—Charles H. Davis

TALOR & CO., W. A. ..... *
Agency—Emery Advertising Corporation
THE TERRY STEAM TURBINE CO. 131
Agency—Gassaway Advertising Agency
TEXAS CO., THE ..... Back Cover
Agency—G. M. Basford Co.
TROY ENGINE & MACHINE CO. ..... *
Agency—Laux Advertising, Inc.

UNION IRON WORKS 60
Agency—Harold Warner Co.
U. S. ELECTRICAL MOTORS ..... *
Agency—The McCarty Co.
UNIVERSAL ATLAS CEMENT CO. 129
Agency—Batten, Barton, Durstine & Osborn, Inc.

VOGT MACHINE CO., HENRY 35
Agency—Farson, Huff & Northlich

WESTERN CHEMICAL COMPANY 116
Agency—Carter Advertising Agency, Inc.
WESTERN PRECIPITATION CORP. 62
Agency—Dozier Eastman & Co.
WICKES BOILER CO. 39
Agency—Price, Tanner & Willox, Inc.
WILLIAMS GAUGE CO. ..... *
Agency—Downing Industrial Advertising, Inc.
WILSON, INC., THOMAS C. ..... *
Agency—Michel-Cather, Inc.
WORTHINGTON CORPORATION 40–41
Agency—Needham, Louis & Brorby, Inc.

YARNALL-WARING COMPANY 8–9, 66
Agency—The Michener Co.

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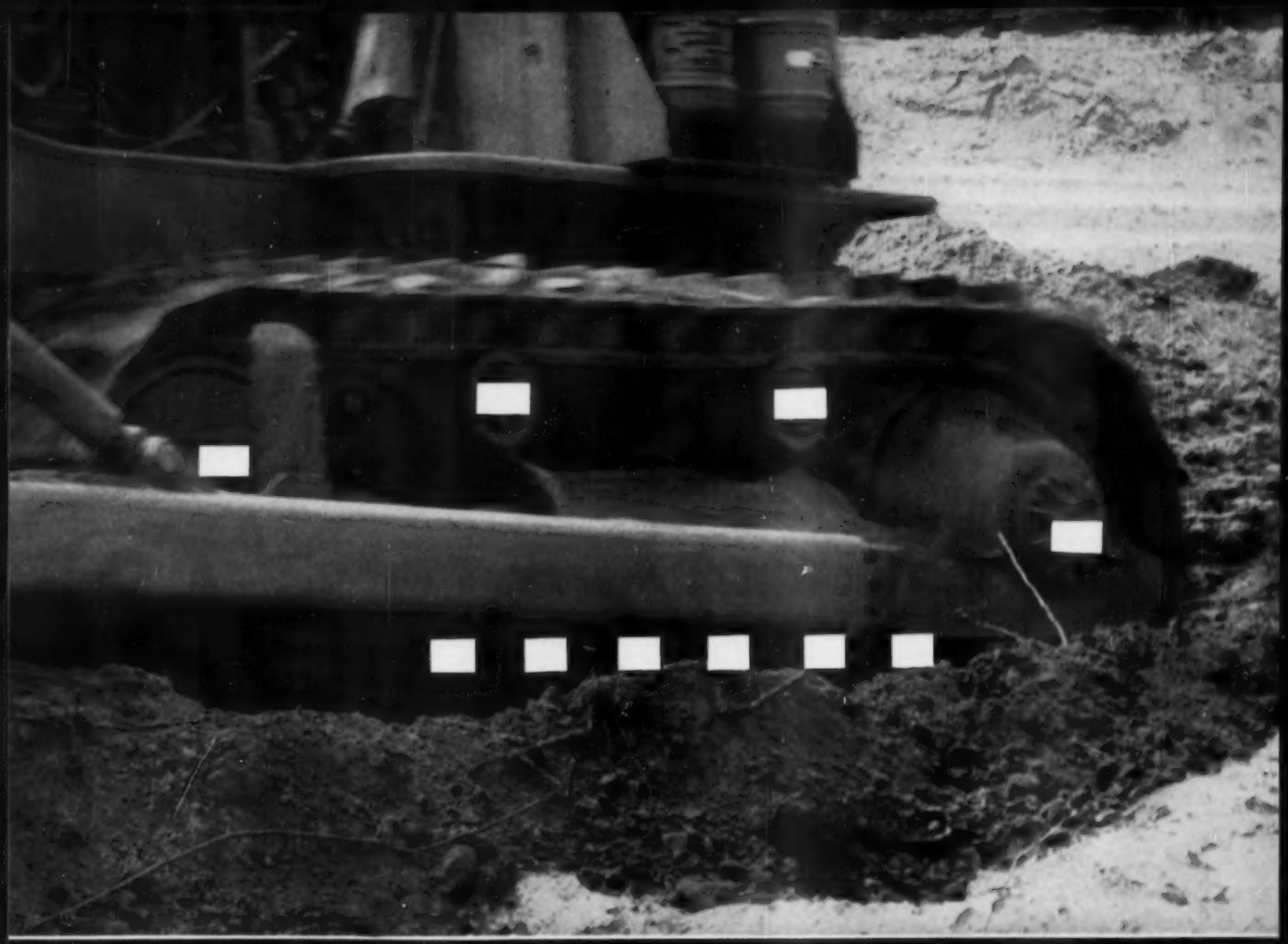

245 hours less greasing time . . .
245 hours more working time EVERY YEAR!

Time saved by 1,000-hour lubrication intervals on your Allis-Chalmers tractor adds up to 245 hours every year—an extra month of production!

On truck wheels, support rollers and idlers, an exclusive combination of positive, spring-loaded seals and tapered roller bearings keeps out dirt and moisture, prevents loss of lubricant.

For 1,000 tractor work hours, you can forget about every grease point below track level. When it's time for servicing, simple low-pressure flush lubrication replaces old grease completely, eliminates seal popping, prevents damage to seal faces. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

IT'S SIMPLE ARITHMETIC!

	Other Tractors	Allis-Chalmers Tractors
No. of greasings per year (5,000 hr)	up to 500	5
Greasing time (av. conditions)	½ hr	1 hr
Time spent greasing	up to 250 hr	5 hr
PRODUCTION TIME GAINED . . . 245 HOURS EVERY YEAR!		

ALLIS-CHALMERS *Engineering in Action*

For more data circle 588 on Post Card

NEW!!
TERRIFIC!!
FAITHFUL!!

AURORA®
General Purpose
CLOSE-COUPLED
CENTRIFUGAL PUMPS

Get acquainted with this new series of versatile, economical and brilliant performers. Compactness, simplicity of design and long life suit these pumps perfectly to a wide range of duties including hot water and chemicals handling — with low NPSH characteristics to meet critical suction conditions.

TYPE BJF
FLANGE MOUNTED

IDEAL for THESE DUTIES

AIR CONDITIONING
REFRIGERATION
COOLANT
HOT WATER
CHEMICAL*
GENERAL PURPOSE

*MAY BE FURNISHED IN SPECIAL ALLOYS TO MEET SPECIFIC CONDITIONS

A FEW OF MANY VALUE FEATURES

SEALS or GLANDS — Available in either as desired.
SPEEDS — 3,500, 1,750 (60 cycle) and 2,880, 1,440 (50 cycle) speeds.
CURRENT — AC or DC — All voltages and phases.
MOTORS — 1/6 to 7 1/2 H.P. drip-proof, splash-proof, totally enclosed, explosion-proof and chemical. Quiet, efficient NEMA standard.
COMPACT — QUIET — ECONOMICAL.

TYPE BJV
BASE MOUNTED

Write for BULLETIN 119 for complete description of AURORA Quality construction and design details.

TYPE BJH HORIZONTAL

CONSULT with US

Aurora engineers will appreciate specifications of your difficult jobs. Only the RIGHT Pump does the job RIGHT.

PUMPS
"by Aurora"
for EVERY NEED in INDUSTRY
for
WATER SUPPLY
CONDENSATE
BOILER FEED
PROCESSING
BOOSTER
TRANSFER
ETC., ETC.

Ask for
CONDENSED
CATALOG "M"

Your Inquiries Will Receive Prompt Attention
DISTRIBUTORS IN PRINCIPAL CITIES

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

40 DEARBORN ST. • AURORA • ILLINOIS
EXPORT DEPARTMENT — Aurora, Illinois — Cable Address "NYABINT"

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Westmoreland Coal Company

HAMPTON COAL
CRITERION COAL

Stonega Coke and Coal Company

GLENBROOK
RODA
CROSSBROOK
STONEGA
DENDRON

Kentucky Sun Coal Company -
Old King Mining Company
No. 1 & No. 2
ASHLO SUNFIRE OLD KING HARDBURLY

Brown Fuel Company
HENSHAW

PREMIUM ANTHRACITE
Product of Jeddo-Highland Coal Company
Hazle Brook

Genco Anthracites & Bituminous Coals

General Coal Company
123 SOUTH BROAD STREET . . . . . PHILADELPHIA 9, PA.

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BUFFALO CHARLOTTE, N. C. CINCINNATI CLEVELAND
IRWIN, PA. NEW YORK NORFOLK

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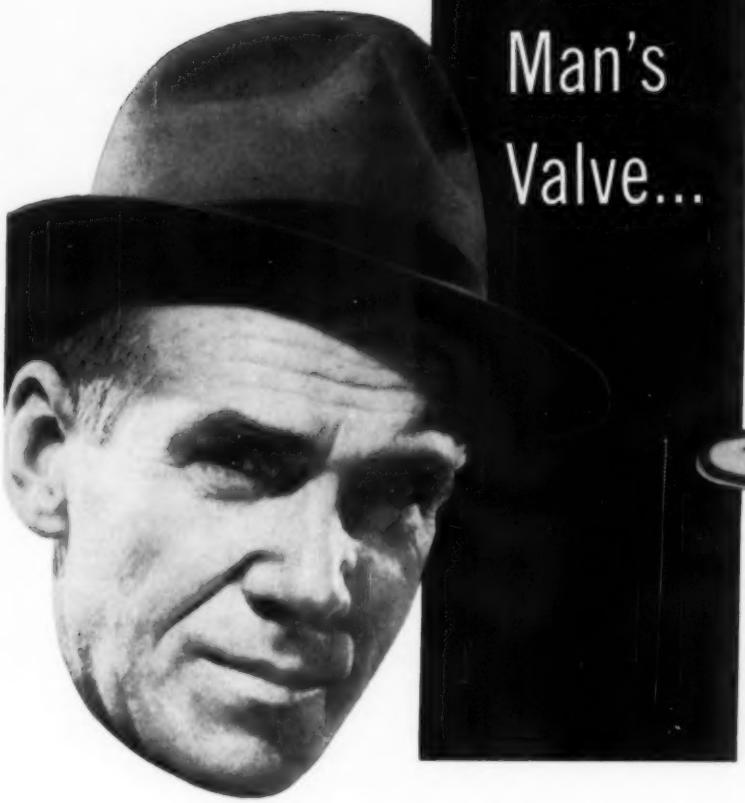

Valve Man's Valve...

CHAPMAN

LIST 960
SMALL FORGED
STEEL GATE VALVE

There are good reasons why men-in-the-know specify Chapman List 960 for more jobs than other small forged steel gate valves. These reasons concern two important points . . . (1) long-range performance and (2) low-cost maintenance.

To begin with, Chapman List 960 valves have wedge faces that are super hard . . . tough enough for severe conditions. These wedge faces are hardened to 800 Brinell by Chapman's *exclusive Malcomizing process*. They can't seize or gall. And even the long-wearing, easily replaceable seat rings are made of hardened stainless steel.

There are no trouble-makers from top to bottom. No full-pressure repacking difficulties. No exposed threading.

For pressures from 380 psi at 1000°F. to 2000 psi at 100°F. (Anything higher, use Chapman List 990 valves.) Sizes range from ¼" to 2" . . . all in many alloy combinations. They come with rising stem with yoke or with inside screw. Bonnet joint ground metal to metal or gasketed, as you prefer.

You'll find them all . . . everything you want . . . in our Catalog 10. Write for your copy, now.

THE
CHAPMAN
VALVE MANUFACTURING COMPANY
INDIAN ORCHARD
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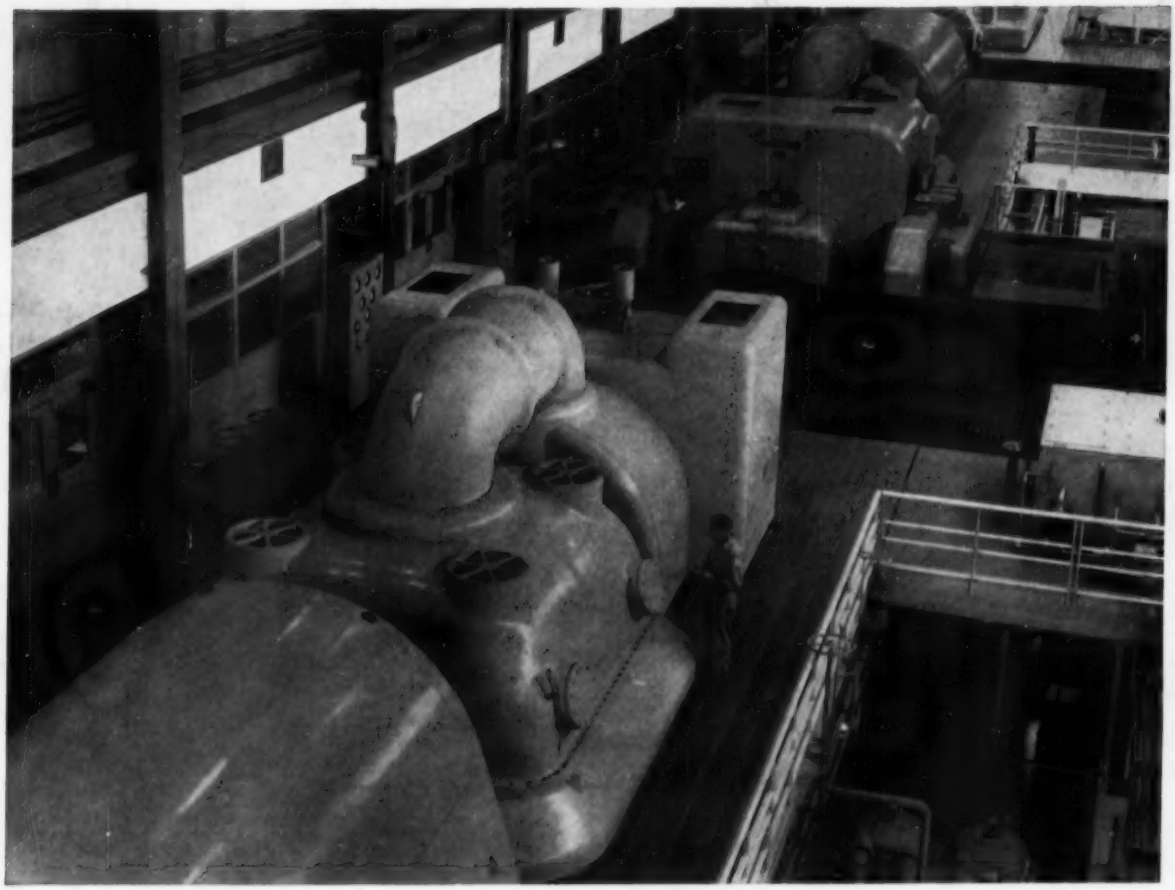

To keep turbine performance at an efficient high

Texaco Regal Oil R&O

Regardless of operating conditions, turbines lubricated with *Texaco Regal Oil R & O* can be depended upon to perform efficiently under peak and valley loads alike.

The reasons for the superiority of *Texaco Regal Oil R & O* over ordinary turbine oils are compelling:

- It prevents sludge, rust and foam, assures normal bearing temperatures and instantaneous governor response.
- It meets the exacting requirements of all leading turbine builders regardless of turbine type, size or special features.

With *Texaco Regal Oil R & O* you can count on extra-strong protection throughout an extra-long service life.

A Texaco Lubrication Engineer is trained to help you select the right turbine oil from Texaco's complete line of *Regal Oils R & O*. Just call the nearest of more than 2,000 Texaco Distributing Plants in the 48 States—or write The Texas Company, 135 East 42nd Street, New York 17, New York.

TEXACO

TEXACO Regal Oils R & O

FOR ALL TURBINES

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